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CIVIL ENGINEERING.

Remarks on the Screw Propeller.

From the Glasgow Mechanic and Engineer's Magazine.

The question of efficiency of the screw propeller, as compared with the ordinary paddle-wheel system of propulsion, is rapidly approaching a practical determination. We do not, however, in the meantime, intend to enter upon a discussion of the particular experiments, complete and in progress; but to examine the subject in its general features, with intention to place it in a proper point of view for subsequent reference.

With regard to the mere effect of the screw, the notices which have from time to time appeared in our pages, making ample allowance for the enthusiasm which naturally associates itself with accounts of the success of new schemes, prove undeniably, that the screw, as a propeller, may fairly be put in comparison with the paddle-wheel; both are found to propel a vessel at a fair speed, and, therefore, the question to be determined, is the balance of advantages possessed by the respective modes of accomplishing the same object.

In any mode of propelling, there is a certain loss of power incurred. The resistance offered by the water to the floats of a paddle-wheel, the thread of a screw of any form, or propelling surface of any kind, or character, is not perfect; there is a certain amount of yield, or recession, of the water, recognized as *slip;* and in this, there is, of necessity, a corresponding loss of power. To express this circumstance less technically, when a paddle-wheel is made to act upon the water, the vessel does not advance through the corresponding space

through which the power is exerted, but passes over a distance considerably less. Commonly, indeed, the useful effect measured in distance passed over by the vessel does not exceed three-fourths of the entire space passed over by the paddles, and frequently the difference amounts to as much as one-third of the whole power expended.

To determine the amount of slip, theoretically, for any given mode of propelling, would lead to calculations much too complicated to be useful; but the amount of experience derived from the working of paddle-wheels of almost every conceivable form and proportion, enables us to approximate very nearly to the amount of power to be allowed in that mode of propelling; and from the logs of twenty-three steam vessels now before us, we may state that the speed of the paddles being 1000, that of the vessel will be very nearly expressed by 739. We have not the same precise knowledge with respect to the slip of the screw, for, independently of experience being limited to comparatively a few instances, the data furnished are less precise, and, therefore, less to be depended on. But making use of such information as we possess, it appears that the difference of efficiency of the two modes of propelling, as respects slip, is not a matter of serious importance. Referring to the Archimedes, from which our most circumstantial information is derived, it appears that the screw is 5 feet 9 inches diameter, with a pitch of 8 feet, the area of the acting surface considered as a disk of the same diameter, acting in the direction of the axis of the vessel, is, therefore, about 26 feet, without deducting the section of the shaft and bearing. The area of the midship section is stated to be 122 square feet; consequently, the ratio of the propelling surface to the area of midship section is as 1 to 4.7, which, it will be observed, is a small proportion of propelling surface compared with the area of paddle-floats usually immersed in steam vessels. Now, in a number of well attested and independent trials, it appears that the average rate of the vessel, compared with that of the screw, is in the ratio of 100 to 129; that is, the power expended is to the useful effect, as 100 to 77.4, or, calling the space passed through by the screw 100, the distance over which the vessel was propelled is expressed by 77.4.

From this it would appear, that the slip is actually less than the average deduced from trials with the paddle-wheel; but, it must be observed, that the average ratio, formerly stated, is deduced from logs of vessels of which we know little beyond their actual rates of sailing, nominal power of engines, and number of strokes; and upon which we observe a difference in respect of their speed and expenditure of power equal to 18 per cent. of the whole power employed. And, further, if we bear in mind that the Archimedes is built to good, though not superior, lines, we must be prepared to compare the action of its propeller with a particular case in which we can ascertain, as nearly as may be, the same data. Possibly, the example of the Great Western may be more generally known than any other, and the data ascertained are very precise. As respects the average immersion of her floats, the average amount may be taken at 180 square feet perpendicular surface; and her average midship section is pretty

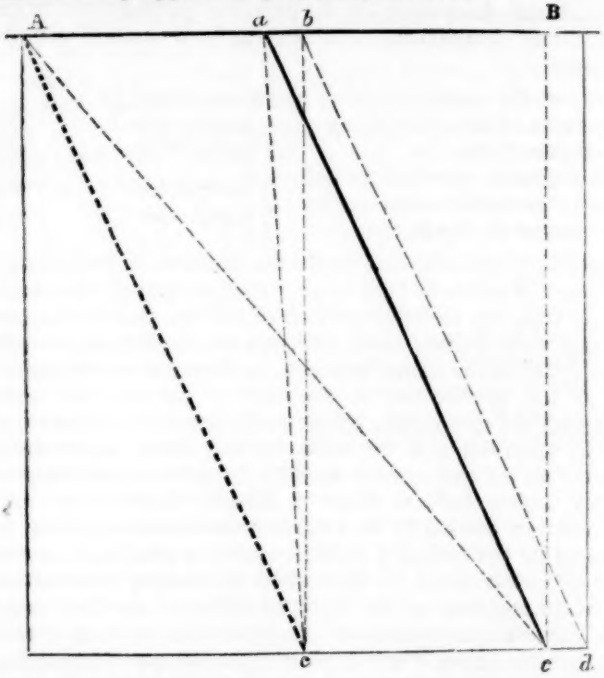
nearly 460 square feet. The ratio of the propelling surface to that of the section, is, therefore, as 1 to 2.56—which, it will be observed, is greatly more than the ratio of these quantities in the Archimedes. Now, in the Great Western, the average speed of the vessel compared with that of the paddles, is pretty accurately ascertained to be very nearly as 100 to 127—that is, the power consumed being 100, the effect produced, measured by the distance passed over, is expressed by 78.7. The comparison between the two vessels will, therefore, stand thus:—

Area of the midship section being expressed by 1.

The area of the propelling surface in the	Archimedes is	0.203
	Great Western is	0.391
Difference of speed of vessel and propeller—that is the amount of slip in the	Archimedes	0.291
	Great Western	0.271

It, therefore, appears, that while the amount of propelling surface in the Great Western is very nearly double that of the Archimedes, compared with the midship sections of the two vessels, the amount of slip is only very slightly less; and, compared with several other vessels, the Archimedes seems superior, as respects the action of its propeller, in the application of the motive power. To account, in some degree, for this result, which could hardly be expected *a priori*, it must be observed, that the action of the screw upon the water is not merely an oblique action, tending to give a rotary movement to the water, rather than to impel it directly backwards. Moreover, the commotion caused by its action in the fluid, is greatly less than that caused by the ordinary paddle-wheel, in which no inconsiderable amount of power must be consumed in beating the surface of the water, in consequence of the oblique action of the float boards. As regards the oblique action of the screw, it will at once be perceived, that the amount will depend upon the pitch and velocity conjointly. It does not depend upon the pitch alone—for the screw being itself carried forward with the vessel—the angle of the inclined plane, formed by the thread, is proportionally diminished as respects its action upon the water. This becomes self evident, if we assume that the vessel with the screw advances through a space equal to the whole pitch of the screw; in this case, it is manifest, that the screw would not *strike* the water, but simply glide through it, and there would be no slip. To ascertain, therefore, the angle at which the water is impelled by the screw, we must take into account the velocity of the vessel, and the amount of slip, or recession, of the water. This may be represented to the eye by such a diagram as that subjoined, in which if A B, represent the direction of motion of the vessel, and A *a*, the distance through which it is advanced by one revolution of the screw, then, it is clear, that the angular position of the thread A *c*, is virtually changed in respect to its action on the water to that of the dotted diagonal line *a c*. The amount of motion given to the water—that is, the amount of slip—is indicated by the dotted position *b d*, of the thread *a c;* for, had we supposed the vessel to

advance to *b*, then the angle *c a* B, would be a right angle, as *c b* B, and there would be no recession of the water—that is, no slip. The screw, therefore, in moving through the space A *a*, in consequence of slip, displaces a column of water equal in diameter to that of the screw, through the distance *b a*, which is, therefore, the measure of the power ineffectually applied in propelling the vessel.



From this, it then appears, that the angle at which any part of the screw strikes the water, is equal to the difference between the angle to which that part of the screw is formed, and the direction in which it moves in accordance with its own rotary motion, and the forward motion of the vessel. This angle, however, it must be observed, decreases from the periphery towards the centre, where it becomes *nothing*, and, in consequence, the propelling power is there also *nothing*. It is even a negative quantity; for, whenever the moving disk of the screw ceases to act as a propelling surface, it is worse than useless, since a certain amount of it must obviously be consumed in maintaining its motion in the water.

It would involve much intricate calculation to express these circumstances in general language; but, referring to the screw of the Archimedes, which is still the best known, we have the following data:—The pitch is 8 feet, and the periphery 18 feet; and, as already stated in another form, the amount of slip is 1 foot 8 inches in one entire revolution of the screw. But the total amount of motion imparted to the water at right angles to the plane of the screw is slightly

less, namely, 1 foot 7 inches. The rotary motion is greatly less. Taking the maximum lateral displacement—that is, the total distance to which any part of the fluid is projected at right angles to the axis—the amount at the circumference does not exceed 8¼ inches, and at 1 foot from the centre, where the circumference described is equal to the advance of the slips, and where, consequently, the lateral motion is a maximum, it only amounts to 10¾ inches. And, it may be observed, generally, that in any screw, the maximum lateral displacement is only equal to half the slip, and occurs at that part of the screw where the circumference is equal to the advance of the slips.

From the principle indicated, we readily determine the pitch which any screw ought to have. The rule is thus expressed by Mr. Galloway:—Divide the velocity in feet per minute, + the assumed amount of slip, by the number of revolutions the screw is intended to make per minute, and the quotient will be the pitch of the screw in feet. Thus, supposing the intended speed of the vessel to be 10 miles an hour, (860 feet a minute) the expected slip 2 miles per hour, (172 feet per minute) and the number of revolutions of the screw to be 120 per minute.

$$\text{Then say } \underset{\text{Revolutions.}}{120} : \underset{\text{Feet.}}{860+172=1032} :: \underset{\text{Revolution.}}{1} = 8.6 \text{ feet the pitch}$$

of the screw.*

In these remarks we have taken no account of the friction encountered by the surface of the screw. By decreasing the pitch, it is obvious that the angular loss will be proportionally diminished; but, it is, at the same time, obvious, that as we decrease the pitch we must increase the surface either directly, or by augmentation of velocity, and thereby increase the friction of the screw upon the water. This friction will, of course, depend much in amount upon the construction of the screw; but, however smooth the surface may be made, it must gradually increase towards the centre, in comparison with the propelling effect. But as the form of screw would lead to a complicated calculation with such data as we possess, we prefer to subjoin the following table of experiments undertaken by Mr. Brunel, jr., for the purpose of determining directly the probable amount of power consumed in overcoming the friction of a plate equal in diameter to the screw of the Archimedes, namely, 5 feet 9 inches. The plate had nearly one-half cut away, and was placed upon a vertical axis, near the edge of section, and made to revolve horizontally in a cistern with, and without, water, as noted in the table, and at different velocities.

* Appendix D, to Tredgold's Treatise on the Steam Engine.

Experiments made at the Great Western Steam-Ship Works on the Friction of a Disk of Iron Revolving in Water; present, Messrs. Brunel, Claxton, Guppy, Humphrey, and others. *Sept.* 1840.

Mark of Experiment.	Mean Pressure on Piston, lbs.	Strokes.	Horses' Power by Indicator.	Revolutions of the Disk.	State of the Cistern.
a	4.6	36	6.0	89	empty.
b	4.3	37	8.79	91	do.
c	4.8	39.3	6.87	98	do.
Card No. 2					
					full of
d	6.39	38.5	8.9	96.0	water.
e	5.70	35.5	7.37	83	do.
f	6.30	45.8	10.45	113	do.
Indicator Card No. 3,					
g	6.6	49	10.78	119	full.
h	6.53	47	11.1	117	do.
i	6.51	45	10.6	113	do.
Indicator Card No. 4.					
k	6.2	41	9.2	101	full.
l	6.0	40	8.7	100	do.
m	5.7	38	7.8	94	do.
Indicator Card No. 5,					
n	4.62	41	6.90	102	empty.
o	4.65	39	6.80	98	do.
p	4.70	37	6.30	92	do.
Indicator Card No. 6,					
q	4.5	37	6.0	92	empty.
r	4.3	41	6.4	101	do.
s	4.4	38	9.0	94	do.
Indicator Card No. 7,					
t	5.6	36.5	7.4	91	full.
u	5.8	38.0	8.0	94	do.
v	6.2	40.0	9.0	100	do.
Indicator Card No. 8,					
A	6.21	40	9.0	99	full.
B	6.30	43	9.8	107	do.
C	6.24	42.5	9.6	106	do.
D	7.10	48.0	12.4	120	do.

These experiments are defective, inasmuch as the direct resistance produced by the edge of the plate is confounded with the surface friction; and still more so, in consequence of the disk being made to revolve in a comparatively small amount of water, in which some degree of rotary motion would speedily be produced by the revolving

disk. It is, however, to be observed, that the gross resistances exhibited in the table, follow very closely the same law as that which governs direct resistance alone; in other words, it is as the square of the velocity. We, therefore, conclude, that the surface friction is likewise as the square of the velocity. It must also be kept in recollection, that the absorption of power by surface friction, is not entirely peculiar to the screw, but extends, though possibly in a much less degree, to the ordinary paddle-wheel; for it is obvious, the floats must encounter a certain amount of friction as they successively enter and leave the water, and which will only be less than that encountered by the disk of the screw, in consequence of their velocity being less. The resistance arising from the edges of the floats in passing through the water, is also to be placed against the resistance encountered by the cutting edge of the screw, and the bearing. This last may be reduced greatly from what it appears in the Archimedes, and the former may also be greatly and advantageously modified, as in Mr. Rennie's propeller.

But apart from these considerations, which may seem to partake more of the character of opinion than of actual fact, it is to be observed, that the results obtained with the Archimedes, as compared with other vessels of good character, show that the sum of the resistances in the screw does not exceed those encountered by the ordinary paddle-wheel. Remarking, that in the case of the Archimedes, the engines are not of the first character, that the gearing by which the power is transmitted to the screw is ill proportioned, and consumes much power needlessly in overcoming the friction of the parts, as well as the constant vibration maintained during the working of the engines. The screw with which the early experiments were made was also very roughly constructed, the surface very unequal, and the bearing clumsy. Yet, under these unfavorable circumstances, and with a power calculated from the effective pressure on the piston, and without deduction for friction, of 145 h. p., the vessel's average speed (in her circumnavigation of Great Britain, in which she sailed 2006 nautical miles in 237 h. 25 m.,) was fully 8.45 nautical miles an hour, and in smooth water fully 9 knots an hour. Comparing this with the gross power of the Great Western's engines, when propelling that vessel at the same velocity, with the advantage of better lines, and greater dimensions, there does not appear to be any discrepancy which would indicate that the screw is less effective than the paddle. Reducing the speed of both vessels to 8 knots an hour, to agree very nearly with several experiments upon both vessels made in smooth water, and when the Great Western was rather more than her average depth in the water, the results stand as in the following table:—

Actual Dimensions.		Relative Dimensions and Power.	
Area of Midship Section Immersed.	Areas of Propelling Surface.	Area of Propelling surface. Midship section = 1.	Engine Power Expended.
Great Western, . . 520 feet,	220 square feet,	0.423	1.023
Archimedes, ... 122 "	26 square "	0.213	1.026

That is, the speed being the same, the power expended is very nearly the same; that is, very nearly one h. p. *gross* to one foot of midship section; while the propelling surface in the Archimedes is only one half of that in the Great Western.

As respects efficiency, it, therefore, appears, that the screw is not in any marked degree, inferior as a propeller to the ordinary paddle-wheel, nor does it seem to possess any superiority. In point of applicability, it has both its advantages and disadvantages. One manifest hinderance to its use in small vessels, designed for shallow water, is the depth to which it projects, and the danger which would constantly attend it of going aground in depths of water quite sufficient to allow a vessel of the same draught of water to be propelled by paddles. For river steamers, therefore, the screw seems a less applicable, and less desirable appendage, than even the bulky paddle boxes; for if once aground, it is useless as a propeller, and should it get aground in a current, there is much probability that the vessel will drift, and leave it. This objection disappears in contemplating its application to a sea-going vessel, with which it has always a sufficient depth of water, and is manifestly less liable to accident and derangement than the paddle. In respect of application it possesses a decided advantage, in admitting of a better, stronger, and simpler form of vessel, with the same amount of material; it requires no paddle-boxes, and to that extent the vessel will be less acted upon by head winds and seas. It is also unaffected in its operation by the trim of the vessel, and allows of the free use of sails. One remarkable advantage of which its application admits, is the increased facility it affords of steering the vessel, owing to the increased current of the water upon the rudder; for, contrary to the opinion which was entertained in the infancy of steam navigation, the greater the velocity of the vessel, the greater is the command of the rudder upon her motion. When the old Comet was ready to be applied upon the Clyde, the proprietors had some difficulty in finding a person to act as captain of it, on account of the supposed difficulty there would be in navigating it at some eight miles an hour through the windings of the river; and latterly, we believe, the command was entrusted to a school-master, who had none of the prejudices inherited by the old *skippers*.

The screw also admits of considerable reduction of the breadth of beam, and of the top weight—which are manifestly of importance in

sea-going vessels. The weight of the paddles is placed entirely below the water line, and no part of the engines need ascend above the same level. In the Princeton steamer, of which a notice was published in our pages of last month, the whole engines and boilers are stated to be four feet below the line of the water. This property may, indeed, be overdone to such an extent as to give the vessel a pendulous motion, which would be about as injudicious as to leave her deficient of ballast. But the power of regulating the trim of the vessel is a property which may be taken advantage of with judicious effect, and which it is highly desirable to possess.

Perhaps the most important property possessed by the screw over the paddles, is its remaining at least very nearly equally effective at all depths of immersion. When a vessel is deep, and the paddles, consequently, deeply immersed also, their action is materially impeded, and a great part of the power of the engines is absorbed in giving motion to the water; when too light, again, the floats do not take sufficient hold of the water, and the amount of slip is, in consequence, greatly increased. In both cases power is wasted—on the one hand in *stirring* round a mass of water needlessly, and, on the other, by ineffectually revolving the paddles. When the vessel is deeply immersed, the greatest effect is required to overcome the increased amount of resistance; but under these circumstances the power is least effective; and, hence the numerous contrivances which have been published under the name of *reefing paddles*, to obviate the evil. In bad weather, also, an enormous loss of effect is experienced in consequence of the rolling of the vessel, the one paddle being too deeply immersed, and the other not sufficiently. These circumstances may, at first sight, seem trivial, yet, in sea-going vessels, it is calculated that not less than a third of the actual power expended is thereby inefficiently absorbed.

It is not presumed, that with the screw the immense sacrifice of power here indicated, would be wholly avoided; but the presumption is, that a large amount of it would be rendered effective in propelling the vessel, and to that extent, *cæteris paribus*, the screw is to be preferred.

Nor can we suppose the screw to be a more delicate instrument of propulsion than the paddles. These last—as every one interested in steam navigation must know—are a constant source of trouble and expense, and are hardly capable of being kept in a good state of repair. This is not at all surprising, considering their lightness of structure, and great size, and that they are constantly subjected to concussion upon the water, independently of extraordinary shocks from heavy seas. From all this the screw is free; its action is uniform, and constantly the same. It cannot be exposed to variations of pressure of the slightest moment, unless it should happen that the vessel was subjected to lateral motion by a heavy sea running obliquely to her course, which can hardly be expected to occur to an extent which would materially affect the safety of the screw bearings, and these are the only parts which it is possible to imagine would at all be endangered by an occurrence of that sort.

One objection which has been frequently urged against the screw as a propeller at sea, is the probability of its being lifted out of the water by the pitching of the vessel in a rough sea. This, however, applies far more forcibly to paddles than to the screw, which is much more deeply immersed, and, therefore, less likely to lose its hold of the water than the float-boards of a paddle wheel. The objection, however, acquires no support from experience; for, in the first place, it is well ascertained that a steamer at sea never pitches to so great an angle as that to which she rises; and, in the next place, she is almost invariably meeting, or passing, the seas, and, consequently, although heaved very violently, the effect is not such as is likely in any way to endanger the action of the screw. The form of the vessel, moreover, ensures an almost steady motion of the stern, even when the swell is very considerable. The variation of displacement of the stern is very rapid—falling off almost to nothing at a few feet below the water-line, and spreading out to a great extent at a few feet above. Forward again, the difference of displacement is comparatively small, and, consequently, the centre of motion is thrown very considerably aft. While the bows, therefore, are thrown alternately high and low in the water, the stern floats nearly steady, the vessel resting on the broad counter nearly at the centre of motion. This circumstance has been minutely observed, and is not stated on merely hypothetical grounds; and, moreover, it was never found that the screw of the Archimedes was uncovered in the roughest weather to which she has been exposed.

The main difficulties attending the application of the screw, consist in the mechanical appliances for conveying to it the motive power of the engines, and for attaining the requisite number of revolutions. The means hitherto put in operation, seem to us, without exception, to be defective. The use of toothed gearing for a purpose of the kind, is, at best, little consonant with our ideas of strength and security against accident. It is true, that toothed wheels may be made sufficiently durable to obviate ordinary casualty, but still they are far from being desirable accessories to a marine engine. Belts and ropes seem still less free of objection. For light machinery, we fully admit the virtue of connexions of that nature; but in cases where 500 to 1000 h. p. are to be transmitted, we much doubt that some connexion less elastic will be required. We do not certainly anticipate in this any thing more than a mere mechanical difficulty which will disappear—as others, apparently, far more formidable have disappeared, and are now forgotten; but, in the meantime, we see no other real difficulty to be surmounted in the application of the screw as a propeller. In this, however, we say nothing regarding the kind, or form, of the screw which we conceive to be the most appropriate and economical as respects efficiency; in the preceding remarks, we have referred only to the form of screw employed in the Archimedes; but we have done so, simply because it is the most generally known, and to save discussion.

On M. De Proney's Brake, or Friction Dynamometer. *By* WILLIAM STEWART.

I beg leave to offer you the following observations on the article relative to M. de Prony's friction dynamometer, given in your pages for October and December last.

I entirely agree with you in respect of the utility, the simplicity, the elegance, and the accuracy of that mode of measuring the mechanical power of prime movers; but I think that the description you have given of the form, and more especially of the dimensions of the brake, employed by Captain Morin, in his experiments on water-wheels, is ill calculated by reason of the expense incurred, to bring into general use an instrument which seems to me about as necessary in the sale and purchase of prime movers, more especially steam engines, as the common balance is in the sale and purchase of grocery goods.

Captain Morin, without doubt, made the brake which he employed, purposely of sufficient strength, to be able to accomplish without accident, or repairs, the series of experiments which he intended to make; and, to make sure of this, no expense was spared, no second consideration, such as the trouble and expense of carriage, occupied his mind,—and, as you inform us, "the whole did not exceed 500 lbs." From this statement, we may presume, that the weight of iron in the composition of the brake was nearly, perhaps altogether, 500 lbs.; the expense of which, including the workmanship, may have been £16; but very few persons will be disposed to lay out such a sum to try an experiment, which, to many, may not appear decisive, and to others it may appear unnecessary. It is certain, that in ordinary cases, such an expense is unnecessary, as will appear hereafter.

In 1821, I was, from accidental circumstances, charged to clean, examine, and repair, if necessary, the steam engine on which M. de Prony performed the first experiment with his friction dynamometer; I may state, in confirmation of what I here advance, that in executing my task, I put two new cast-iron tubes of 9 or 10 inches diameter into the boiler, the old tubes having been left full of water, and being unemployed during the severe winter of January, 1821, were rent by the congelation of the water, nearly from one end to the other, in a direction parallel to the axis. Most of the joints in the boiler had also to be renewed; all the working parts of the engine were taken apart, cleaned, carefully examined, and with equal care returned each piece to its place. Nothing was wanting in the engine except a few springs to be changed in the metallic piston of the steam cylinders; the repairing of a few joints, and, what was more essential, the filling up of a blown hole, nearly an eighth part of an inch in diameter, in the steam cock of one of the cylinders, which was so situated as to admit the steam from the steam pipe, communicating with the boiler into the steam cylinder on the opposite side of the piston, at the time it ought to have been exhausted.

Apart from these small exceptions, the engine, in all its parts, was of the very best workmanship, executed at Messrs. Ferrier and Ed-

wards' manufactory at Chailot, in Paris. The engine was situated in Gros Cailau, in Paris, on the left bank of the Seine, and destined to raise water for the use of the city.

The engine was of the high pressure kind, with two cylinders, on the principle invented by Mr. Woolf, and was constructed under the direction of Mr. Edwards, previously a partner with Mr. Woolf, under the firm of Woolf & Edwards. The engine was sold to Mr. Ferrier, director, and, I believe, proprietor of the said water works, as equivalent to 20 horses power, but was found by M. de Prony to be equal to 16 horses power only.

From this experiment I infer, that there is error and exaggeration in the supposed advantage of double cylinders, with expanding steam on Woolf's principle. The firm of Ferrier & Edwards never would have sold an engine for a power greater than that which they believed it to be capable of giving—and previous to this experiment of M. de Prony, there was no method other than vague calculation to ascertain the power of steam engines.

These details which have not hitherto been published, and which perhaps none but myself could give circumstantially, may be interesting to many of your readers, inasmuch as they are connected with the subject of your article before alluded to, and with the first application of the friction dynamometer. Other reasons, however, have determined me to communicate them, viz., 1st, because it is universally agreed, that in performing any experiment, every circumstance connected with the experiment ought to be noted, both before and after, as well as during the experiment; for the reason that sometimes circumstances apparently unimportant at the time, may afterwards lead to important results. 2nd, because I consider the experiment by M. de Prony, on the steam engine, at Gros Cailau, as being decisive in showing the fallacy of the estimated power of double cylinder steam engines, as introduced by Messrs. Woolf & Edwards. It is of importance to state, that nothing was wanting to render the experiment complete; the engine was perfectly new, having been at work only a few days after its erection—that it was most efficiently constructed, and highly finished—that immediately preceding the experiment it was carefully examined, cleaned, and repaired, where wanted, in all its details, and that for the express purpose of being tested by M. de Prony, and by order of a legal decision of one of the courts of law in Paris. 3rd, because this experiment is a striking example, showing how it happens, that from small, and apparently, trifling, causes, sometimes great results are obtained; in this case, I am satisfied in my own mind, that had the small *blown* hole already stated to have been discovered in the steam cock not existed, (which hole must have reduced the power of the engine, at least, one-half,) it is probable that no discussion between the buyer and the seller of the engine would have taken place,—and that M. de Prony would not have been called upon to test the power of the engine; and, consequently, on that occasion, at least, his attention would not have been directed to the investigation of the measurement of the force of prime movers, and his ingenious and simple dynamometer might have been

as yet unknown. And 4thly, allow me to add that I feel proud in being able to associate my name with a circumstance which gave occasion for an invention, characterized by you "as one of the most elegant and useful inventions which France has bequeathed to practical mechanics."

But, to resume, the brake, or friction, band employed on this occasion by M. de Prony, did not, like that of Captain Morin, weigh 500 lbs. Its weight did not exceed 25 lbs., neither was it necessary that it should.

Since that time I have had occasion, in contested cases, to employ the friction dynamometer, and can assert that, when applied to test the power of steam engines of twenty horses' power, the iron work may be made under 20 lbs. weight, and the whole expense not exceed £1. For water-wheels with wooden shafts, a larger and stronger friction-pulley and band is necessary; but even for that, in ordinary cases, 100 lbs. weight may be sufficient. An expensive link-chain is not essentially necesssary: a bar of flat iron, or strong sheet-iron, bent, will answer equally well, and the cost not exceed £4.

Four sets of setting screws, for the ring, or pulley, is preferable to three sets, as every practical mechanic knows. A plate of iron ought to be put between the point of the set screws and the wooden shaft, and the open space between filled with wooden wedges, as described by Captain Morin. For cast-iron shafts, a very small friction ring will suffice. The expense will be reduced in proportion.

From what has been here stated, it appears certain that the practical operation of ascertaining the power developed by prime movers, by the use of M. de Prony's dynamometer, is as simple, as easy, and as little expensive in its application as you have shown the calculation to be.

Liverpool, March 12, 1844. Ibid.

Proceedings of the Institution of Civil Engineers.—From the London Athenæum.

Atmospheric Railway—June 4.—The applicability of the system of the propulsion of railway carriages, by the pressure of the atmosphere upon a piston, traveling within an exhausted line of pipes, has occupied a portion of three meetings; and, although much time has been devoted to the discussion, it cannot be said that any positive conclusion has been arrived at. Indeed, when it is considered that the system has only been tried upon a line peculiar in its locality, in its steep gradients, in the engine having only to exert power in drawing the carriages in one direction, and their descending by their own gravity, and in the trains being only required to run a distance of a mile and three quarters, without stopping at any intermediate station, it may be argued, that although, as is evident from the testimony of the several speakers, great results have been obtained, it is scarcely possible to infer what the results would be on lines with gradients in

both directions, with a great number of heavy trains at short intervals and under all the varied circumstances of ordinary traffic. It appeared, however, to be the opinion, that the present system of atmospheric propulsion, although susceptible of much improvement, was in a more advanced state than the system of traction by locomotives, at a corresponding period from the date of the introduction of the several systems. The various previous plans of Medhurst, Vallance, and Pinkus, for somewhat similar systems, were explained; and it was shown that the system had been taken up by Clegg and Samuda, where the former speculators had abandoned it, and, as usual in such cases, the practical improvers had been more successful than the inventors. The principal improvement is in the continuous valve, and the mode of closing it by a mixture of tallow and bees-wax, which, under all variations of temperature, remained unchanged, and enabled a good vacuum to be formed. Many other alterations in the mechanical details were also described. Mr. B. Gibbon, engineer of the Dalkey line, stated his satisfaction with the manner in which it worked; thirty-five trains per day had at times been conveyed without danger, and with regularity; the train was enabled to be started in one minute after the engine commenced working to form a vacuum. Mr. Samuda detailed the progressive trials at Wormwood Scrubbs during two years and a half, until it was laid down at Dalkey, where a load of 50 tons had been propelled up gradients averaging 1 in 115; and a maximum velocity of nearly 50 miles per hour had been obtained, with an engine which was stated to be 100 horse power, using as a divisor, 66,000 lbs., raised one foot high in a minute. This deviation from the ordinary calculation of Boulton and Watt, who used 33,000 lbs., was justified on the plea, that steam engines were now made in such a superior manner, that their effective nearly doubled their nominal power, and that the usual acceptation of the term "horse power," was no longer to be relied upon. This position was combatted by several members, who argued that the commercial question should not be mixed up with the scientific inquiry; and that for the latter purpose the accepted divisor of 33,000 lbs., for the horse power, should have been used, when the power exerted would have appeared nearly double what had been quoted, which would materially affect the question of the cost of first laying down, and the expense of subsequent working. In considering the comparative merits of traction by locomotive engines, by fixed engines with ropes, and propulsion by the atmosphere, it was argued, that in the two former cases, the weight of the moving power must be carried along the rails at a corresponding cost and loss of power, added to which was the loss resulting from the slip of the driving wheels in the one case, and the friction of the rope against the pullies in the other; the destruction to the rails, resulting from the beat of the driving wheels, being put out of the question. Against this it was argued, that with the atmospheric system, the whole power of the engine must be used,—whether for heavy, or light, trains; that a power capable of pumping out the leakage, stated at 10 horse power per mile, must be always provided, although it was only exerted for a part of the length of each

section; and that the real power employed at Dalkey, if calculated by the usual standard of Boulton and Watt, was shown by indicator diagrams to be nearly double what had been stated, and that, consequently, a greater outlay was required than was imagined. The additional security in traversing the rapid curves of the railway at high speed appeared to be admitted. A curious circumstance was mentioned, which deserves more attention—it was, that the temperature of the air, on leaving the exhausting air pump, was increased to upwards of 200 degrees; and that there was a certain absorption of power consequent upon this increase of temperature. Although much time has been devoted to the discussion, the question was not fully examined, nor were all the necessary data clearly stated, so that for all practical purposes we shall only arrive at the comparative value of the new system after it has been applied to such a line as the Epsom.

Purifying Coal Gas—June 11.—Mr. A. Angus Croll read a paper on the purifying of coal gas, and the application of the products thereby obtained, to agricultural and other purposes. The process consists in passing the gas through a solution of sulphuric acid of the strength of two and a half pounds of oil of vitriol to 100 gallons of water, and by a continuous supply of acid, so that the proper amount of free acid might be always kept in the vessel, the whole of the ammonia in the gas was abstracted, preventing the corrosive effect of this impurity on the fittings and meters through which it was transmitted, and rendering the gas capable of being used in dwelling houses, and also enabling the gas companies to use dry lime, instead of wet lime, purifiers without producing any nuisance on the opening of the vessels, by which a considerable saving was effected, while, at the same time, sulphate of ammonia of great purity is obtained, and of such a strength that the evaporation of one gallon produces eighty ounces of this valuable salt, instead of fourteen ounces, which was the quantity rendered under the former process. The author concluded by showing the advantage to agriculture by the application of this produce; he stated that various experiments, upon an extensive scale, had been tried with this manure with great success: one example will suffice for giving an idea of its powers. One half of a wheat field was manured with sulphate of ammonia, at the rate of 1¼th cwt. to the acre, and at a cost of 1*l.* 2*s.*, the other half with the ordinary manure; the latter produced only 23¾ bushels, but the former under the treatment of sulphate of ammonia produced 32¾ bushels. In the discussion that ensued, in which Prof. Grahame, Mr. Cooper, and many members took part, the advantages of the system were confirmed, and the necessity for its extension insisted upon. The various modes of purifying gas, and the value of the products obtained for agricultural purposes, were canvassed at length. It was stated, that seeds steeped for 40 hours in a solution of one pound of sulphate of ammonia to one gallon of water, sown in unmanured land, produced a heavy crop, and remained green during a dry season, when every other kind of vegetation became yellow and withered. Another remarkable feature

was, that faded flowers when plunged in a weak solution of sulphate of ammonia, were, in a short time, restored, and that plants watered with it attained extraordinary health and beauty. The great loss resulting from the leakage of the gas through the joints and the pores of the cast-iron pipes, was incidentally mentioned, and it was stated that in some instances it had amounted to from 25 to 75 per cent. of the total quantity produced.

Supply of Water in case of Fire—June 18.—A paper by Mr. Braidwood, superintendent of the fire brigade, gave the results of his experience as to the best means of rendering large supplies of water available in cases of fire, and on the application of manual power to the working of fire engines. The author stated, that if water could be obtained at an elevation, pipes, with plugs, or fire-cocks, on them, would be preferable to any mode at present in use, and that the best mode of using manual power was by applying the greatest aggregate amount of power to the lightest and smallest machine; that the reciprocating motion was to be preferred to the rotary; and that a fire engine with two seven inch cylinders, and eight inch stroke, weighing seventeen and a half cwt., was the most advantageous size that could be adopted.

Combustion of Coal.—In the paper by Mr. A. Murray, the author considered the quantity of atmospheric air chemically necessary for the complete combustion of a given quantity of coal. The practical recommendations given, were, that the supply of air should be as free as possible; the entrance into the ash-pit should not be less than one-fourth part of the area of the fire grate; the depth of the ash-pit should be about two feet and a half, no advantage being found to result from its being deeper; the space between the fire bars should be 7-16th inch, but that depth should be regulated by the kind of coal used; for any kind of coal it should not be less than 3-8th inch, nor more than half an inch; the fire bars were recommended to be made as thin as was consistent with their required strength; half an inch in width had been found to be a good proportion. The space in the furnace above the fire bars was recommended to be made large, about three cubic feet to each superficial foot of fire grate, when such an amount could be obtained. The proper area of the flue was next considered, with reference to the bulk of the products of combustion and their velocity, showing that the area requisite for the quantity chemically required was found to be much too small, and, that in practice, it should not be less than two square inches for the products of combustion from each pound of coal consumed in the grate per hour. Taking a furnace in which thirteen pounds of coal were burned on each square foot of fire grate per hour, (which was stated to be a usual rate of combustion in steam boilers,) the area of the flue to every superficial foot of the grate would be twenty-six square inches. The area of the chimney was recommended to be three-fourths of that of the flue. The mode of conducting the flue to the chimney, and the angles formed in its passage, were also considered. The time occupied by the gases in passing through the flues of a

boiler, from the instant of their generation to that of their reaching the chimney, was shown not to be of importance, provided that the incandescent gases were to be sub-divided, that all the particles were brought into contact with the boiler, and were made to part with their caloric, as was the object in the construction of locomotive and other tubular boilers. The amount of heating surface recommended was in the proportion of eighteen square feet to each foot of fire grate where the combustion was carried on at the rate of 13 lbs. per square foot per hour, though a larger amount might be employed in land boilers, where there was no objection against cooling down the products of combustion in a greater degree. The principles were stated to be applicable to all kinds of boilers, used either for land, or marine, purposes.

Removal of the Sunderland Light-House—June 25.—A paper was read descriptive of the removal of the light-house on the North Pier at Sunderland, by Mr. J. Murray. The light-house, built in 1802, was 76 feet in height, and 15 feet in diameter at the base, slightly tapering upwards to the lantern. It was built of polished stone, and had within it a spiral stair-case; its total weight was 338 tons, which being concentrated on an area of only 162 square feet, rendered the task of its removal in an entire mass a work of much difficulty and danger, especially when its height was considered. Mr. Murray was induced to propose its removal without taking it down, in consequence of the expense which would have been incurred in the establishment of a temporary light on the pier, the cost of building another light-house, and the success with which dwelling houses had been moved entire in the United States. The decision was accelerated by a serious breach being made by the sea on the wall of the pier on which it stood, and in consequence the work of removal was commenced on the 15th of June, 1841, by the masons cutting the holes for inserting the timbers for forming the cradle; those directly beneath the building were carried by 144 cast-iron rollers, traveling on eight lines of iron rails, and the outer timbers supporting the braces and struts, were placed upon slide balks, which were lubricated with a mixture of soft soap and black lead to diminish the friction. The power applied was by means of several drawing and pushing screws, and by three winches, with ropes and tackle blocks, worked by eighteen men. On the 2nd of August, the mass was moved a distance of 28 feet 6 inches in a northerly direction, to place it in the line of the new pier. After changing the position of the rollers and slide balks to adapt them first to a curve of 647 feet radius, and then to a straight line in an easterly direction, the cradle with its load was propelled steadily forward, at an average rate of 33½ feet per hour when in motion, the entire time of moving over 447 feet being thirteen hours 24 minutes. Much time was, of course, occupied in taking up and relaying the rails and balks, and in preparing a solid foundation for them as the mass advanced; so that it was not until the 4th of October, that the light-house arrived at the extremity of the pier, where the foundation was prepared for it. The timbers were withdrawn gradually, the spaces

being filled up with solid masonry, and the building was stated to have remained to the present time in a solid state, without the slightest appearance of even a crack in the walls. A light was exhibited in the lantern, as usual, every night during its transit. The entire cost of executing the work was 827*l.*, and it was shown that an actual saving of 893*l.* had been made by adopting the plan of removal, instead of building a new light-house.

Constructions to Retain the Sides of Deep Cuttings, &c.—A paper by Prof. Hosking, containing some suggestions for the introduction of constructions to retain the sides of deep cuttings in clays and other uncertain soils, was then read. These constructions were chiefly intended to be introduced in situations where, on account of the bad nature of the soil, open cuttings, or tunnels, would be expensive and dangerous; they consisted of buttress walls, placed at intervals along the length of the line, and opposite to one another, strutted at their toes by an inverted arch, and above by built beams of brickwork, at given heights, discharging arches being turned from buttress to buttress to carry the beams; the buttresses were to be made the springing walls of longitudinal counterarched retaining walls, and all the force exerted against them would be converted to the buttresses, and from thence to the arches and built beams. The author then gave a detailed estimate of the expense of forming an open clay cutting with slopes at 2½ to 1, and of the proposed constructions, the same data being taken in both cases, from which it appeared that the difference was nearly one-third in favor of the construction. It was stated by Capt. Vetch, that a similar kind of construction had been successfully used in the Moseley cutting, on the line of the Birmingham and Gloucester Railway, and General Pasley stated that Mr. Adie had introduced that kind of construction on the Bolton and Preston Railway.

Rebuilding the Piers of Sarclet Harbor.—A paper, by J. Bremner, described the mode adopted by him for rebuilding the piers of Sarclet Harbor, (Caithness, N. B.) after they had been twice destroyed by the sea, to whose action it is much exposed, the waves frequently breaking over the works at a height of 50 feet. The works required to be completed with great rapidity, as the season in which they could be carried on was very limited. Mr. Bremner, therefore, contrived several gigantic cranes, which were fixed at about 20 feet above high water mark, the longest commanded a radius of 115 feet, and by it a cargo of 20 tons of large stones could be unloaded from a barge, and conveyed a distance of 230 feet in half an hour; and it afforded similar facility for laying the blocks of stones in their places in the building, as also for depositing materials in front of a breach which had been made by the sea in the new works, which, without such efficient means, would have been, as before, entirely destroyed. The machinery and general mode of building adopted by Mr. Bremner, were described, and some remarks as to the inefficiency of vertical pier walls for resisting the force of the waves in exposed situations appeared to attract attention.

Experiments on the comparative Strength of Hollow and Solid Railway Axles.

At the meeting of the Institution of Civil Engineers, on the 23rd ult., a report was read of the result of some experiments made under the superintendence of Mr. Bury, of the London and Birmingham Railway, at Wolverton, on the comparative strength of hollow and solid railway axles. The result of these experiments showed that the solid axles resisted the effects of torsion more than the hollow ones, and that while the journals of the hollow axles were broken by fifteen and seventeen blows respectively from a 30 lbs. sledge hammer, a solid axle received 374 blows from the same hammer before it was broken. All the axles experimented upon were made from precisely the same quality of iron, by the Patent Shaft and Axletree Company of Wednesbury. A report was also stated to have been received from Mr. M'Connell, of the Birmingham and Gloucester Railway Company, of experiments made for his own satisfaction, on an axle also made by the Patent Shaft and Axle Company, without any knowledge that it would be subjected to such trial. Mr. M'Connell's report, having been printed, was not read at the meeting, printed documents being excluded by the rules of the Institution, but as the subject is one of much interest to those connected with railways, and the public generally, we subjoin extracts:

The following is the statement of the experiments made by Mr. Bury, at Wolverton.

Ten hollow and ten solid axles were sent by the Patent Shaft and Axle Company, to Mr. Bury, and the lathe work was done under that gentleman's superintendence.

The soundness of the manufacture of the hollow axles was tested by two having been cut longitudinally through their centres.

A hollow and a solid axle were then placed alternately in a frame with each journal, in a firmly fixed block, and levers were fixed on the wheel seats in opposite directions. The length of the levers from centre of axle to centre of chain for suspending the weight, was six feet. Weight of lever 158 lbs., weight of chain 29 lbs., total 187 lbs.

	Hollow.	Solid.
Diameter of the axle,	4½ inches.	3⅞ inches.
" journal,	2½ "	2½ "
" wheel seats,	3¾ "	3¾ "
Length of journal,	5 "	5 "
Weight of axles,	189 lbs.	209 lbs.

The deflection was at a radius of two feet from the centre of the shaft. With a weight of six cwt., the deflection in the hollow axle was one-eighth of an inch; in the solid axle none; with a weight of 14 cwt., the deflection in the hollow axle was one-fourth of an inch, with a permanent set of 3-16ths lbs.; and on the solid axle 5-16th of an inch, without any permanent set. When the weight was increased to 22 cwt., the deflection of the hollow axle was 1 7-16; and of the solid 1 9-16—each of them having a permanent set of 1¼ inch. The torsional effect of 22 cwt. was equal to 85 tons.

Experiments were then tried upon the journals of the axles, dimensions and weights as before; they were firmly fixed on wheels, and the outside ends struck with a 30 lbs. hammer.

The first hollow axle fractured after receiving fifteen blows, and the journal broke with six further blows. The second hollow axle fractured after receiving seventeen blows, and the journal came off with fourteen further blows.

A solid axle then received one hundred blows on the end of its journal, without being fractured, or much bent. It was then turned over, and received one hundred blows in an opposite direction, bringing it into its original position without a fracture. It was then turned to the other quarter at right angles, and received eighty-seven blows, still without a fracture; it was then struck eighty-seven blows in the place where the first hundred blows were given, which brought it off. The iron exhibited a fibrous texture in a longitudinal direction.

Mr. M'Connell's experiments, made in September last, were with a patent axle, taken indiscriminately from forty supplied to the London and Birmingham Railway Company, by the Patent Shaft and Axletree Company.

The axle was placed in a pair of tender wheels, and weights suspended from a lever, commencing with a weight of 347 lbs., equal to a torsional effect of fifteen tons, and gradually increased up to 1761 lbs., giving a torsional effect of seventy tons. The deflection, with the weights up to 700 lbs., was scarcely observable; and with the extreme weight of 1761 lbs., it amounted to only eleven-sixteenths of of an inch, with a permanent set of three-sixteenths.

Several blows were then given with a weight of 316 lbs., let fall from a height of 4½ feet, and afterwards from a height of nearly nine feet, on the opposite side. The journal, after receiving eighteen, or twenty, blows, was then turned at right angles, and broke off with the first blow, exhibiting a fibrous fracture, and solid in the centre.

The journal on the opposite end of the axle was then tried with blows of a hammer 28 lbs. weight, and after one hundred blows, was bent about three-eighths of an inch. It was then turned one-fourth round, and was bent, by one hundred blows, three-sixteenths of an inch. Two other angles were then subjected to the same number of blows, and after receiving these four hundred blows it remained without a fracture.

An old axle, marked best scrap, was tried on one of the journals, with a hammer of the same weight, and broke with twenty blows, the fracture presenting a crystalized appearance; this axle had been faggoted with flat bars. Journal 4½ inches long, and 2¼ inches diameter.

An old axle, marked P, was next tried on the journal, which broke with fifty-eight blows of the same hammer, fracture presenting a fibrous appearance. Journal 4½ inches long, and 2 9-16 inches diameter.

It was thought by some of the members that the cause of the comparative weakness of the hollow axles, arose from the difficulty of preventing an inequality on the inner surface, and that it would be

satisfactory if further experiments were made on the hollow axles, in which particular attention was paid to this point.

A paper was then read by Mr. Glyn, relative to the fracture of railway axles, which he attributed to the constant succession of blows received by the axles in traveling. The action was stated to be similar to that of an axle laid on the edge of an anvil, and subjected to a series of smart blows of a hammer, while in constant rotation. The fracture presented the appearance of a clean annular cleft all round for the depth of half an inch into the body, the centre part being crystalized, and reduced so much as to be unable to bear the weight and the torsion to which the axle was subjected by the pressure of the brake on one of its ends. These observations had induced the railway company to apply the power of the brake upon both wheels simultaneously, thus avoiding the torsional strain.

Lond. Railway Mag.

AMERICAN PATENTS.

List of American Patents which issued in January, 1844, *with Remarks and Exemplifications. By* CHARLES M. KELLER, *Examiner of Patents.*

1. For an improvement in the *Combination Lock for Doors;* Sabin Colton, Philadelphia, Pa., January 6.

We have here another of that almost endless variety of devices for preventing the picking of door and other locks, by means of impediments put in the passage of the bolt, which are intended only to be removed by setting them to a combination of letters, or figures, which may, for greater security, be varied at pleasure. In the modification, under consideration, the bolt is thrown in and out by a knobbed spindle and bit, and the impediment to its inward movement is a slide which works in a box attached to the back end of the door-plate. When the bolt is out, and the slide is pushed and retained in, it projects from the lock-plate, and behind the bolt far enough to be a complete check, and it is retained in that situation by buttons, or disks, on the ends of three, or more, spindles that work in the slide. These buttons, or disks, have a portion of their diameter cut off, so that in one situation they are narrow enough to pass with the slide through the box, and in other situations they project beyond the width of the slide, and catch on to a piece which projects from the back of the plate; the forward end of these spindles is adapted to receive a key, by which they are turned, and by figures, or letters, marked on the key and door-plate, the combination desired can be formed and pointed out as in the Bramah Lock. The patentee claims "the manner in which he has combined the slide contained in the box, and the spindles therein carrying the buttons on their ends, which are made to catch on the piece" projecting from the back of the lock-plate,

"when acted upon by the key; said apparatus operating as a whole, substantially as described."

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2. For an improvement in *Platform Spring Scales;* George R. Moore, Brattleboro', Vt., January 6.

Instead of attaching, or suspending, the article to be weighed to a rod attached to a spring, according to the usual mode of making spring scales, it is placed on a platform attached to the top of a vertical rod suspended by the ends of a cross bar attached to it, to two arms of a rock shaft, which is also provided with two other arms opposite to them—to one of these the spring is attached, and to the other, which is longer, is suspended a dish to receive the weights for weighing beyond the force of the spring. From one end of this rock shaft another arm extends down, and is jointed by a link to an index hand, turning on a pivot, which points to the graduations on an index on the box that surrounds the whole, except a portion of the hand, and the end of the lever to which the dish is suspended. The lower end of the rod to which the platform is attached, is kept in a vertical position by a jointed bar, in the usual way.

The claim is limited to the "combination of the spring balance, with the steel yard, substantially, in the manner described." "And, also, in combination with the above, the hand, or indicator, and index, arranged as specified."

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3. For an improved *Let off Motion for regulating the delivery of the Yarn in Weaving Looms;* William H. Brayton, Warren, Bristol county, R. Island, January 6.

The yarn beam is, by means of a cog-wheel and pinion, put in connexion with a friction pulley, around which passes a friction band, having one end fixed to the frame by a screw adjustment, and the other by means of a rod, or spring, to the lower end of an upright lever jointed to one of the swords of the lathe, the upper end of which is jointed to a finger, or short arm, projecting downwards from a small shaft extending across the back of the lathe; and from this shaft project upwards, two other arms, or fingers, which bear against the back of the flighter, or spring reed. The yarn is not given out by the beam unless the friction band on the friction pulley is loosened, which does not take place until the strain of the web, in beating up, be sufficiently great on the flighter, or spring reed, to cause it to yield, and then, by the connexion above described, the friction band is loosened, and the yarn given out.

The claim is limited to the "mode of connecting the yarn beam with the flighter, by means of the friction strap and pulley."

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4. For an improvement in *Bee Houses;* Aaron E. James, Point Pleasant, Mason county, Va., January 6.

The patentee says:—"What I claim as my invention, and desire to secure by letters patent, is the combination of several hives furnished

with inclined floors, and two honey boxes on their tops with the bee palace in the manner set forth; that is to say, said hives being movable, and having the entrance for the bees in the middle, between the two inclined floors, and corresponding to an entrance in the floor of the palace, said entrance having an inclined alighting board, and slides to close the hives at pleasure."

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5. For a *Machine for Moulding Bricks*; John Booth and William H. Stevenson, Columbus, Lowndes county, Miss., January 6.

In this machine there is a cistern with a vertical shaft and arms for mixing, or tempering, the clay in the usual manner. This cistern is square, and its bottom is pierced with four holes corresponding with the four sides of the cistern. Below this cistern the frame is adapted to receive two mould frames that run entirely across, at right angles to each other, and so let into each other as to slide freely at right angles, and have the tops of all the moulds (which are placed one set at each end,) level, and as nearly in contact with the bottom of the cistern as may be consistent with the operation of the machine. The moulds are filled in succession by an inclined board, called the filler, attached to an arm near the lower end of the mixing shaft, which, in passing around, forces the clay through the holes in the bottom of the cistern, into the different sets of moulds in succession. Below the filler there is a curved arm attached to the shaft, which acts as a cam to move the mould frames that are provided with rollers on opposite sides for this purpose. After the filler has passed over and filled a set of moulds, the cam follows and pushes it out, and the opposite set in, to be in readiness for the filler.

The claim is in the following words, viz.,—"What we claim as our invention, and desire to secure by letters patent, is the method of filling and returning the moulds, as described; that is to say, by means of the follower, or filler, and the curved lever, (cam) combined, operating, and arranged, substantially, as set forth. And we also claim the manner in which we have combined with the cistern and its revolving shaft for tempering the mortar, the mould carriages constructed, and operating, substantially, as set forth."

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6. For an improvement in the *Air-tight Stove;* John Cline, Norwalk, Huron county, Ohio, January 6.

This improvement consists in adding to the well known air-tight stove, a small pipe which extends from the front of the stove to the smoke-pipe, or valve-plate, with the end turned, and extending a short distance up the smoke-pipe, for the purpose of giving a slight draught to carry off the gases and vapor generated in the stove. The claim is limited to this improvement.

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7. For a composition of matter for rendering water-proof articles manufactured of leather, such as *Boots and Shoes, &c.;* William J. Roome, city of New York, January 6.

This compound consists of "32 parts mutton, or beef, tallow, either,

or both, 32 parts linseed oil, 24 parts yellow beeswax, 6 parts neats foot oil, 4 parts lamp black, and 2 parts litharge, or red lead." We are instructed to "place the materials in a pot of sufficient size, and reduce the materials to a liquid mass, by the application of heat, when all is melted to keep stirring the composition until it becomes nearly cold, or while in the liquid state to *fill* it into tin, or earthen, vessels, for use."

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8. For an improvement in the *Flax and Hemp Breaker;* Constant B. Butler, Petersburg, Lincoln county, Tenn., January 6.

In the breakers heretofore known and used, the swords, or blades, that break the flax, or hemp, only act on it in one direction, and the object of the present improvement is to arrange them in such manner that they will act on both sides of it, and thus more effectually break the woody part. This is done by having two sets of permanent swords, or breakers, sufficiently far apart to receive the flax, or hemp, between them, and two sets of movable swords, or breakers, attached to a sliding frame, or gate, one set acting on the upward, and the other on the downward, movement of the gate.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the construction of the breaker by which the hemp, or flax, is acted upon in the upward, as well as the downward, stroke, thus acting on the opposite sides of the hemp; that is to say, I claim the combination of the upper and lower permanent breakers, or sets, with the upper and lower blades attached to the movable sash; this being the principle of the invention which I desire to secure."

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9. For a mode of straining the strings in the act of *Tuning Pianos;* Joseph S. Ives, Bristol, Hartford county, Conn., January 6.

The patentee says,—"In my improved method of straining the strings of piano fortes, &c., instead of the ordinary tuning pin, I employ with each string, a tuning pin which has a screw on it, intended to operate as an endless screw upon a worm-wheel which turns on pivots in a proper metallic bearing. The worm-wheel has a groove turned in it for the purpose of receiving the wire which is to be strained thereon. The lower part of the tuning pin is enclosed by a metallic socket, which is driven into the tuning pin block, where it is held permanently.

"What I claim as new therein, and desire to secure by letters patent, is the manner of forming and combining the tuning pin, the worm-wheel with its grooves, and the metallic support in which they turn, so as to receive and give tension to the respective wires, as set forth."

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10. For a machine for preparing *Hands, or Bundles, of Tobacco,* for being packed; David Smith, South Hill, Brunswick county, Va., January 15.

The object of this improvement is to press the hands, or bundles, of tobacco, by means of rollers so arranged that the bundles of tobacco

will come out of the machine in a regular form. The rollers are arranged like the rollers of a copper plate press, except that the upper one is grooved, and that there are guide pieces on the bed of the press which fit into the grooves of the rollers, the space between the grooves and guide pieces being equal to the desired width of a bundle, or hand, of tobacco.

Claim.—"What I claim as new, and desire to secure by letters patent, is the combining of the guard, or guide, pieces with a pair of rollers, one of which is furnished with rectangular grooves; the respective parts being so arranged as to produce the intended effect, substantially in the manner set forth, together with such variations of the same as leave its principle of action unchanged, producing a like effect by equivalent means."

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11. For a machine for *Shaving Shingles;* Simeon Wood, Worcester, Mass., January 15.

In this machine the shingles are shaved on both sides, by means of two shaving knives, that are made to approach each other by two sets of cams that act on arms projecting from the stocks of the knives. These two sets of cams are arranged on the shafts of two cam-formed rollers that draw the shingle through between the knives; they are so formed as to hold on to the wedge formed shingle equally from butt to point, and, therefore, they must have the form of a volute; the cams that act on the knives being of the same form. The ends of the stock of the under knife turn down at right angles, and work up and down freely in the frame, and are hollow to receive freely the turned down ends of the upper knife; these resting on helical springs at the bottom, which tend constantly to separate the knives when liberated by the cams. The shingle bolts are fed to the knives by turning rests joined to two endless chains passing over rollers, and these rests are provided with arms that bear on guide ways, to prevent them from turning until they reach that portion of their circuit where they descend, at which time the arms have reached the end of the guide-ways, which liberates the rest, and permits it to leave the end of the shingle bolt, which is then drawn through by the cam rollers.

The patentee says,—"I am aware that a patent has been granted to another person for a shingle machine, in which the shingle is shaved and tapered by means of two knives that are made to approach each other as the shingle passes through, and, therefore it will be understood that I do not claim this as of my invention; but what I do claim as my invention, and desire to secure by letters patent, is the combination of the cams that force the knives to approach each other with the cams that draw the shingle between the knives, substantially as described; and I also claim the described arrangement of the stocks to which the knives are attached, by making the ends of the upper one slide in the hollow ends of the under one,—springs being interposed between their ends to force the knives apart at the end of each operation. And, finally, I claim the turning rests for feeding the

shingles in combination with the chain and guide, for the purpose and in the manner described."

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12. For an improvement on the *Compound Shovel Plough;* Robert Nelson, West Point, Tippecanoe county, Indiana, January 15.

This is for the purpose of separating the ploughs, or drawing them nearer together. The outside ploughs of the gang are attached to a bar on each side of the beam, and jointed to it at the forward end, the back end sliding on a segment bar of iron projecting from each side of the beam. In this way the ploughs which are attached to the back ends of the bars, can be drawn nearer to, or farther from, each other, this being effected by a hand lever having two arms (at right angles to the third arm, or handle,) jointed by means of links to the back end of the two bars, by the turning of which, to any degree required, the distance of the ploughs can be regulated. At the back of the plough-frame there is a notched plate of iron arranged in a semi-circle, (called the "comb,") for the purpose of holding the hand lever at any point required. The claim is limited to the "combination and arrangement of the bars and lever, so as to effect the contraction and expansion of the cultivator, and, in combination with this, the iron comb."

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13. For a machine for *Cleaning Grain,* called the "Centrifugal Smut Machine;" Meredith Mallory, Mount Morris, Livingston county, New York, January 20.

This machine consists of two disks, one permanent, and the other movable, provided with several rows of teeth, commencing at about the middle of their semi-diameter, and extending to their periphery. The diameter of the rotating disk, which is the under one, is less than the upper, or permanent, one, which is provided with two, or three, rows of teeth beyond the periphery of the rotating disk. There is a fan attached to the shaft of the rotating disk, and the whole is enclosed by a conical case.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the mode of scouring, or cleaning, grain, by causing it to pass from the centre of the revolving disk to its circumference by centrifugal force, said disk being armed with teeth, arranged and combined with an upper stationary disk, furnished with teeth, as set forth. I claim the arrangement and combination of these disks, and also in combination therewith, the fans and curb, or casing, as described.

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14. For improvements in machinery for *Making and Finishing Boat Oars;* Bennett Potter, jr., and Abiather F. Potter, Hubbardston, Worcester county, Mass., January 20.

This is a modification of that kind of machines for turning irregular forms, such as gun-stocks, lasts, &c., in which the pattern acts on a guide-wheel, having its bearings on the same carriage as the cutter wheel, which carriage has two movements, one longitudinal to carry the guide and cutter-wheels from end to end, and the other transverse

to enable the guide-wheel to follow the irregular form of the pattern in both directions. In turning oars, which are necessarily of great length, it would be a matter of some difficulty to prevent the pattern from yielding when moving the guide and cutter-wheels. To prevent this yielding, the pattern is made in two parts, the round part being made permanent, as there is no necessity for its turning, the form in the direction of the circumference being regular, and the flat part, or blade, movable, at the junction of the two there is a standard which gives ample support, and is so arranged as to permit the guide-wheel to pass over it as if it were a continuation of the handle part of the pattern. The movable part is rotated by a mandrel in the same manner as the piece of wood from which the oar is to be turned. There is a rest called "bearings," in the specification, attached to a carriage connected and moved with the cutter-wheel carriage, whilst moving along that portion of the oar which constitutes the handle, for the purpose of supporting and steadying the wood whilst under the action of the cutters; but as these bearings cannot pass over the flattened part of the oar at the end of the round part, the latch, which unites the two carriages, is liberated from a holding pin on the cutter-wheel carriage, and is there held until the cutter-wheel carriage returns, at which time the two are reunited, and travel back together.

Claim.—"We claim making the pattern, by which the oar is formed, or against which the guide-wheel acts, of two parts, in such manner that one of the same, or that from which the handle is shaped, shall be stationary, while the other, or part which shapes the blade, shall revolve, the whole being as set forth. We also claim arranging the cutter-wheel and bearings upon separate carriages, for the purpose of arresting the action of the bearings during the operation of the cutters upon the blade part of the oars; the said carriages being connected together, and disconnected from each other by means of a latch and pins."

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15. For an improved *Reverberatory Furnace*, for the purpose of directly converting mineral, or ores of iron, into wrought-iron, at the first operation, by the process of puddling; Simeon Broadmeadow, of Manayunk, Philadelphia county, Penn.: assigned to William Green, jr., of Woodbridge, New Jersey, January 20.

[See specification p. 117.]

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16. For an improvement in the *Boot Crimp;* Josiah Copeland, of Weymouth, Mass.: assigned to Abraham Thayer, and then to Josiah M. Reed, of Boston, Mass., January 20.

We have here a modification of that kind of boot crimp, extensively used in some portions of the country, in which the leather is stretched by a clamp that holds the corners of the leather, and is drawn out by a screw passing through a nut cut in it, and bearing in a socket in the back edge, or heel, of the form. In this modification the ends of the leather, instead of being clamped on the block, which is drawn out by the screw, is simply laid against the sides of the block which has a

pyramidal form with the base towards the form, and over it is slipped a clasp, which has the sides of the same inclination, and notched, or serrated, when the screw draws out the block, and stretches the leather, this draws the clasp still tighter, and, we are told, that the screw clamp is effectually superseded by this simple arrangement of the clasp.

Claim.—"I do not claim strictly the combination with a pyramidal frustrum, or block, of another piece of metal forced down upon, or over, it by a screw, or other contrivance, separate from the main straining screw, and for the purpose of confining the corners, or edges, of the leather between the said pieces of metal; nor do I claim the forcing of the two jaws, or pieces, of metal together by a screw, or other contrivance, separate from the main straining screw; but that which I do claim, consists in the manner above described, of arranging the block and clasp, so that the turning up of the straining screw shall, at the same time, perform the double operation of confining the ends of the leather between the block and clasp, and of stretching the leather over the boot form; the whole being substantially as above specified."

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17. For improvements in *Self-Setting Head and Tail Blocks*, for setting the log on the carriage of a saw-mill; Thomas C. Theaker, Bucyrus, Crawford county, Ohio, January 20.

The head and tail blocks, under this patent, as under many others that have preceded it, have a slide to which the dogs, &c., are attached, with cogs on the under side, into which the cogs of a pinion take, the arbor of this pinion being placed across the head, or tail, block, so that by the turning of the arbor the slide is moved to one side, or the other. The arbor on both blocks has a segment of a cog-wheel on the end that projects outside the block, which is operated by a vertical sliding rack, and as the segment cog-wheel is connected with the arbor by a ratchet, when the rack is forced up, the arbor is rotated, which operates the slide to set the log, and, on its descent, the segment cog-wheel turns, and carries back the ratchet. On the tail block, the vertical rack is forced up by an inclined plane attached to the floor of the mill; but as it is necessary that the head end of the log should be set quickly, and at the very time the saw passes out of the log, the vertical rack is forced up by a weighted lever, one end of which is jointed to a pitman, that passes through a hole in the floor just under the position of the vertical rack at the end of the back motion of the carriage. The other end of the weighted lever is provided with a cord that passes over a pulley, and is attached to a sliding hook which is disengaged by a pin at the end of the back motion of the carriage, to liberate the weighted lever, which then descends and forces up the pitman and vertical rack; the sliding hook being caught by the carriage at the end of the forward motion, to draw up the weighted lever to repeat the operation.

Claim.—"What I claim is the combination of the vertical rack which operates the slide, the pitman, and weighted lever operated in the manner substantially as set forth. I likewise claim the combi-

nation of the vertical rack, segment rack, (cog-wheel) and ratchet-wheel, operated, substantially, as set forth by the inclined plane."

18. For an improved mode of *Setting the Log on the Carriage of Saw-Mills;* John Miller, Lexington township, Stark county, Ohio, January 20.

This is for setting the tail end of the log, which is, to a certain extent, done in the same manner as in the preceding patent, except that the ratchet-wheel on the end of the arbor is actuated by a lever, instead of a segment cog-wheel, and vertical rack. This lever, instead of being moved by coming against a single inclined bar to move the slide, comes against a succession of inclined blocks jointed to the floor, so that the log is set by a succession of small movements instead of a long one. The inclination of the blocks can be regulated at pleasure by means of wedges that pass in between them and a bed timber designated by the letter T, in the claim, and at the end of this series of blocks there is an inclined piece of timber, designated by the letter U, which conducts the end of the lever over the end of a long spring, to enable it to run back without being caught by the inclined blocks.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is making the guide-blocks in sections, so as to set the log by several operations of the lever acting on the ratchet-wheel, instead of one operation, in combination with the timbers T and U, and the spring V, the guide-blocks being regulated by wedges, or other analogous devices, all as herein described."

19. For an improvement in the *Planting Plough;* Thomas H. Hoskings, Crawfordsville, Montgomery county, Indiana, Jan. 20.

The patentee says,—"My machine for planting corn is to be so formed, that it may be attached to the common plough, for which purpose it has a projecting arm extending forward, through the end of which a joint pin, or bolt, passes, by which it is so connected with the plough as to keep it in its proper position. The machine has a single wheel which runs in the furrow made by the plough, and on one side of the wheel there is a hopper for containing the corn. A pin on one face of this wheel is brought into contact with a lever which raises a slide on one side of the hopper, and allows the grain to drop out once in every revolution of the wheel. The distance of the hills from each other will be determined, therefore, by the diameter of this wheel.

"What I claim is the manner in which I have arranged the respective parts of said planting machine, so as to connect it with the common plough by means of a joint pin, allowing it to be attached to such plough between the handles, and to be detached at pleasure, in the manner, and for the purpose, set forth."

20. For an alleged improvement in the *Method of Propelling Boats;* Gabriel Hippolyte Moreau, Paris, France, January 26.

We have here a modification of the well known duck's-foot paddle.

The flaps, or paddles, are jointed to a frame, or frames, actuated by a steam engine, or other first mover, the pivots of the said paddles being near to one edge, and they are held, during their return action, with their plane in the direction of the boat's motion, their widest side abaft; and to insure and expedite their closing at the commencement of the direct action, there is a set of inclined surfaces, or stops, against which their back, or narrow, edges strike at the end of the return, or back, stroke, which causes them to turn slightly, and present a portion of their face to the resistance of the water the moment they commence the direct action. These flaps, or paddles, close against bars in the frame, or frames, which bars slide, and are connected with a bar in the vessel, so that by shifting, and again returning them, after the paddles have been partly turned, the propeller can be made to act backwards, to back the boat when required.

Claim.—"Having stated the nature of the invention, and the manner of making and using the same, I would have it understood that I do not claim propelling vessels by means of reciprocating paddles, but what I do claim, and desire to secure by letters patent, is the method herein described, of causing the paddles at the end of the return stroke to assume a position inclined to the plane of their motion, so that on starting, the resistance of the water shall close them, by the combination of the paddles, or shutters, with the obstacles, or inclined surfaces, for the purpose, and in the manner described, whether the paddles, or shutters, be attached to vertical, or horizontal, axles. I also claim the shifting of the bars against which the shutters, or paddles, fold, so that the paddles can be made to act in backing the vessel when desired, as herein described."

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21. For improvements in *Steam Generators;* Gabriel Hippolyte Moreau, Paris, France, January 26.

The claim is in the following words, viz.—"I claim making the generator of a series of small horizontal tubes, all on the same plane, in combination with, and opening into a tube of greater diameter, placed at right angles with them, or nearly so, the opening, or connexion, between each tube in the series, and the large tube being equal, or nearly so, to the diameter of the tubes in the series, so that the communication, between the tubes of the series, shall be common for the water and steam. I also claim regulating the feed of the water into the boiler by a floating valve in the feed pipe, the specific gravity of which shall cause it to close the aperture in the feed pipe, when the water reaches the proper level, as described. I farther claim preventing the rush of water from one side of a series of tubes to the other, in marine and other locomotive boilers, by means of a partition disk placed in the tubes, as described. And, finally, I claim regulating the intensity of heat in the furnace, and thereby regulating the generation of steam, by the pressure of steam acting on a piston connected with the damper which regulates the draught of the chimney, in combination with the means described for overcoming the friction of the moving parts in reopening the damper, when the pressure is reduced, as described."

The first claim needs no explanation. The second item claimed consists of a valve in the induction pipe, which is attached to a float in such manner, that when the water has reached the high water mark, the valve rising with the float, closes the valve, which cannot open until the water sinks in the boiler; this valve is placed in a vertical tube by the side of the generator, and constituting a part of the supply pipe. The third item claimed, consists simply in placing a disk in the tubes which compose the generator, which disk is of less diameter than the inside of the pipe, and which, therefore, does not prevent the flow of water and steam, but which presents sufficient impediment to the motion of the water, as to prevent a sudden rush of the water from one end to the other by the sudden careening, or pitching, of the boat. And, finally, the mode of regulating the draught of the chimney is by connecting the damper of the chimney with a piston, acted upon by the steam in a cylinder, by means of a lever which extends beyond the piston, and is there provided with a box, or vessel, having a valve at the bottom; when the piston is forced up by the pressure of the steam, the extremity of the lever opens a valve in the bottom of a reservoir of water, which runs into and fills the vessel at the end of the lever, the weight of which, after the steam has reached the gauged elasticity, overcomes the friction of the piston and other moving parts, forces down the piston, reopens the damper, and opens the valve at the bottom of the vessel which discharges the water, and puts the apparatus in readiness to act again, should it become necessary.

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22. For an improvement in the *Plough;* William K. Allen, Brownsboro', Oldham county, Kentucky, January 31.

This plough is made altogether of iron; the standard is jointed to the land side, and connected with the mould-board by a setting screw bolt. The beam is jointed to the top of the standard, and the back end, which is slotted, is connected with the handles by a setting screw bolt; and then two links are jointed with screw-bolts to the lower end of the handles, the standard and beam.

Claim.—"I make no claim to the individual parts of the plough, nor to making it entirely of iron; but all that I do claim, and for which I ask letters patent, is the adjustable plough stock, in combination with the adjustable handle, as set forth."

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23. For an improved *Ointment for the Cure of Piles;* Wm. Willshire Riley, of Mansfield, Richland county, Ohio, January 31.

The following are the instructions contained in the specification:—"Take of the cream of sulphur two ounces, of powdered nut galls one ounce, of powdered opium one grain, and mix them intimately, adding lard enough to give it a proper consistency for ointment, mixing it thoroughly; which is to be applied to the parts affected as often as twice every twenty-four hours, until a cure is effected: all of which I claim as my invention, and desire to secure by letters patent."

24. For a machine for *Forging and Swaging Anvils;* John Taylor, Shade Gap, Huntingdon county, Pa., January 31.

The swages in this machine, as in all others, are made one movable, and the other permanent; the latter is called, in the specification, the bed: the two are so formed as to give to the anvil, when completed, the required curves, and to prevent this operation from forcing the surplus metal to the face, and rendering it uneven, there is a vertical rest, which is a continuation of the bed, against which the face of the anvil to be acted upon is placed. After the proper curves have been given to the anvil, it is secured in a double screw clamp jointed to the floor, and on each side there is a common anvil placed at such distance from the clamp, that the two sides can be forged alternately, without removing the anvil from the clamp.

Claim.—"I make no claim to the frame, hammers, and guides. What I claim is the bed on which the anvil is formed, shaped to correspond with the required form of the anvil, in combination with the vertical face, rest, or gauge, as set forth. Likewise, the jointed clamp in combination with the side rests, or anvils."

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25. For an improvement in *Filters, used in the Manufacture of Sugar;* John Watson, Chorley, England, January 31; patent to run fourteen years from the 23d of June, 1842.

This filter is composed of two concentric, perforated, conical, or cylindrical, vessels, made of wire cloth, or other porous material, with the space between the two filled in with animal charcoal. The vessel, thus constructed, is closed at the top and bottom. The liquid to be filtered is introduced by a pump through the bottom, which is also provided with another tube for discharging the contents when needed. When it is required to apply pressure to the liquid, there is a third tube passing out through the bottom, and turned and carried up to receive a column of liquid high enough to give the required pressure.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, first, employing animal charcoal for filtering purposes between two vertical surfaces (or nearly vertical) of wire cloth, or other porous material, the liquor to be filtered entering the charcoal through one of the vertical surfaces, and escaping from it through the other, as set forth; secondly, I claim the method of constructing my apparatus by forming it of two vessels, one within the other, having animal charcoal in the space between them, said vessel being constructed and operating, as set forth."

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26. For a new compound, or paint, denominated "*the Indestructible Carbonic Paint;*" Joseph Weisman, Philadelphia, Pennsylvania, January 31.

The patentee says,—"The nature of my invention consists in combining the metal of carbon, or purified graphite, with caoutchouc and shellac, together with a small portion of acetate, or sugar, of lead; the ingredients being mixed with linseed oil and spirits of turpentine.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of carbon, or pure graphite, with caoutchouc and shellac, together with acetate of lead, linseed oil, and spirits of turpentine for the purpose set forth, forming a perfectly indestructible anti-corrosive pigment, which also serves the purposes of anti-attrition."

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27. For an improvement in *Ships' Blocks;* Stephen Waterman, Greenwich, Conn., and D. Russell, New York city, January 31.

This improvement consists simply in putting the metal strap used on ship blocks, on the inside, instead of the outside, of the cheeks, so that these straps are directly against the sides of the sheave, thus shortening the bearings of the pin which may, therefore, be reduced in diameter.

Claim.—"What I claim is constructing the blocks in the manner described, with the straps passing down through the shell on the inside close to the sheave, in the manner and for the purpose described."

Re-issues of Patents.

1. For an improvement in *Gun Locks;* Ethan Allen, late of Grafton, Mass., now of Norwich, Conn., January 15, date of patent November 11, 1837.

As this patent was re-issued for an amendment of the claim, we will simply give the new claim, and refer the reader to vol. xxii, of this Journal, 2d series, for a description of the lock.

Claim.—"I do not claim the several parts of the lock separate from each other, as in my surrendered patent, but that which I do claim consists in the combination with the trigger, or sear thereof, and the cock, or tumbler, thereof, of the apparatus by which the cock is elevated from the cap, or nipple, and discharged, or permitted to descend thereon, by the force, or reaction, of the main spring whenever the trigger is retracted by the finger; the said apparatus consisting of the dog, or catch, jointed, or hinged, or otherwise suitably applied to the tumbler, or cock, or to the trigger, as the case may be, the same being operated by the trigger, or by the same and other parts, and constructed, substantially, in the manner set forth."

Improvements added to Existing Patents.

1. For an improvement in the machine for *Breaking and Screening Coal;* Joseph Battin, Philadelphia, Penn., January 20, added to a patent granted Oct. 6, 1843.

The patentee says,—"In the specification to which this is supplementary, I described two rollers having teeth upon their peripheries for the breaking of the coal, these rollers being geared together, and operating as described in said specification. I have since found that this part of the process is much facilitated by the addition of a third,

or auxiliary, roller, of smaller diameter than the two at first used, and placed above them. What I claim therein as new, and desire to secure by letters patent, is the combining the third, or auxiliary, roller, with the machine for breaking and screening coal, as patented by me on the 6th of October, 1843. It will be manifest that a second pair of rollers might be used instead of the auxiliary roller, but these would require more power to move them, and would not perform their office any better than the single roller."

List of American Patents which issued in the month of September, 1841, with Remarks and Exemplifications. By CHARLES M. KELLER, *Examiner of Patents.*

(Continued from Vol. IV, 3rd Series, p. 279.)

1. For an improvement in the *Rotary Pump;* Samuel A. Lee, Boston, Mass., Sept. 4.

We make the following extracts from the specification, viz.,—"The outer part of this pump consists of a stationary drum of cast-iron, or other metal, which is to be placed firmly upon any stationary stand. Within this drum there is a central shaft, which is sustained by the two heads of the drum, said heads forming the bearings within which said shaft revolves. Attached to this shaft there are two disks, or round plates, of metal, which, when in place, stand, respectively, at the distance of about an eighth of an inch from the heads of the drum, and their edges reach to within about the same distance of the interior of its periphery. The space between these disks constitutes the chamber into which the water is to enter from the reservoir, and from which it is to be forced by the revolution of the shaft and disks, and by the action of a cam and valves, so constructed and arranged as to effect that object."

"The water is to enter the chamber of the pump through the revolving shaft, which is made hollow for that purpose, being bored out from one end to a depth which shall cause said opening to extend within the shaft to the line of the further side of the chamber between the two disks. A water-way is then cut from said hollow shaft into the chamber, and this water-way is covered by a valve within the chamber; which valve, when closed, will prevent the return of any water from the chamber into the lower supply pipes. Between the two revolving disks, constituting the sides of the pump chamber, there is a cam consisting of a curved piece of metal which extends from the shaft to the edges of the disks, and which fills the space between these disks, extending from one of them to the other. The convex side of this cam is covered with leather, which extends to its outer edge, and there comes into contact with the rim of leather which lines the periphery of the drum; this cam might be denominated a revolving piston, as it serves to draw the water from the reservoir, and to force it up to the point where it is to be delivered. The convex side of this cam serves to raise a valve, which, when not so raised, occupies the chamber, and forms a partition across it, extending from the

shaft to its outer rim, and which, when raised up by the cam to allow it to pass, is received within a semi-circular valve chamber, on the upper side of the drum, from which chamber the delivery pipe proceeds. . . . . The edges of this valve are leathered, so as to cause it to work water-tight between the sides of the chamber of the pump, and those of the valve chamber above."

"What I claim therein as my invention, is the manner in which I have constructed, arranged, and combined the hollow revolving shaft, the revolving disks and cam, or piston, attached thereto, and the segmental valve, with the chamber into which it is raised by the cam, in the manner set forth, so that these parts, with their appendages, will co-operate with each other in producing the intended effect, substantially as described."

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2. For an improved *Suspender Strap*, to be attached to pantaloons; David B. Cook, New York, Sept. 4.

The patentee says,—"The nature of my invention consists in attaching to the waist, or waist-band, of the pantaloons, a strap to be made of broad cloth, India rubber webbing, or any other material the pantaloons may be made of, about eight inches in width, where it is attached to the pantaloons, two inches from the front of the waist-band of the pantaloons to the back of the hip seam, and gradually tapering off to about one inch in width, where it meets, and is attached to the suspender buckle attached to the strap. What I claim as my invention, and desire to secure by letters patent, is combining the suspender with the waist, or waist-band, of the pantaloons by means of the strap attached to the pantaloons, as herein described."

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3. For improvements in the *Lamp* for burning lard and other concrete fats; George Carr, Buffalo, Erie county, N. York, Sept. 4.

This improvement consists in making the metallic conductors, or heaters, heretofore used in lamps for the combustion of the concrete, or partially concrete, fatty materials, hollow and so arranged as to heat them, and the air they contain. For the argand lamps the inner deflecting button, with its sustaining stem, are hollow, and at the bottom communicate with a tubular air space surrounding the wick tube, and from this a flat tube extends into the reservoir of lard, &c. This method of heating, or liquifying, the fatty materials, is described as applied to a series of lamps with the common burner. The lamps with their lard reservoir, rest on a hollow air vessel which extends up and surrounds them, so that the heated air may extend entirely around the vessels containing the lard, &c. This air vessel is to be heated by means of an auxiliary lamp below.

Claim.—"I do not claim to be the first inventor of lamps for this purpose, or of using conductors of metal for rendering the concrete materials liquid, by conveying heat thereto from the flame of the lamp; but what I do claim as of my invention, and desire to secure by letters patent, is the employment of hollow, or tubular, conductors,

within which the air is to be heated, and which hollow conductors, so containing heated air, are to surround, or to be surrounded by, the burner containing the wick, in lamps of the argand kind, and are to extend also into the reservoir, for the purpose and in the manner described. I likewise claim the applying of the heated air vessels, as modified and described; the said apparatus, under every change of form, being so constructed as to operate upon the concrete materials by the combined influence of good metallic conductors, and of heated air, and, substantially, in the manner made known."

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4. For a *Horse Power* for driving machinery; Moses Davenport, Pittsburg, Allegheny county, Penn., Sept. 4.

This horse power is constructed on the general principles of the sun and planet motion. The main wheel is a permanent ring with cogs on the inner periphery, into which mash two traveling pinions that have their bearings in the sweep plate, turning on a central shaft, and drawn by the horses. On the shaft of each of these pinions there is attached a driving wheel, which mashes into a central pinion, and as these two wheels are on opposite sides, they balance it in its bearings. The central pinion is mounted on a shaft having the belt wheel near the bottom, the shaft turning on a pivot at the bottom of the frame, and being sustained at the top partially by a support which extends across the frame, and through which it passes. This support is between the central pinion and the belt wheel, on the lower end of the same shaft. The sweep plate has a hollow cylinder in the middle, in which the central pinion rotates; its sides being so much cut out as to enable the driving wheels on the traveling pinions to reach and mash into this pinion: and the under side of this hollow cylinder is so formed as to fit and run in a channel made for this purpose in the upper part of the support for the central shaft. In this manner the several moving parts are kept at proper distances apart, and are free to rotate. The sweep frame is supported on the outside by rollers traveling on the rim of the main wheel.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the employment of the hollow cylinder attached to the sweep plate, having openings through which the driving wheels communicate motion to the (central) pinion working within it, for the purpose and in the manner described. And I also claim the support (having a channel for the reception of oil, into which works the lower part of the hollow cylinder,) in combination with the hollow cylinder, for the purpose and in the manner specified."

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5. For a mode of making *Berths for Vessels*, which answer the purposes of a *Locker;* Harmon King, New York city, Sept. 11.

The object of this improvement is to arrange a berth front to the top of a locker situated along the side of a vessel, or in front of, and below the usual berths, in such manner that the front of the berth can be thrown back to get at the inside of the locker with facility, or to use the top of the locker for a seat. The movable front is attached

to two metal arms that pass through slots, or holes, cut in the top of the locker, and are hinged, by means of a rule joint, to the bottom of the locker. There are covers fitted to the arm-holes, or slots, in the top, which fit in to hold the arms when thrown forward, or back.

Claim.—"I do not claim as my invention any of the separate parts of the vessel's berth; but what I do claim as my invention, and wish to secure by letters patent, is the combination of the movable berth front aforesaid, with the metal arms, hinges, or rule joints, arm holes, covers, &c., in the manner herein described, or in any other substantially the same, so that a good and proper berth may be readily and expeditiously adapted for use upon that which appears to be, and is, used for an ordinary seat, or locker."

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6. For manufacturing *Seamless Hats, &c., of Leather;* James S. & William Wibirt, Buffalo, Erie county, N. York, Sept. 4.

A piece of leather of the required size, is put on the top of a hat block, and bent down, and a string passed over it to hold in the folds which are then to be rubbed in, whilst in a moist state, with a scouring iron, or tool, until the body of the hat is formed, and the rim spread out. After the hat has thus been formed and dried, it is to be rendered water-proof by a composition of linseed and neats foot oils and caoutchouc, and then colored and varnished.

Claim.—"We do not claim, as our invention, the well known process of crimping leather into various forms, as this has long since been known; nor do we claim the making of hats and caps of leather, as this has been done by sewing the parts together, so as to give the form required. What, therefore, we claim as our invention, and desire to secure by letters patent, is the new fabric described above, consisting of hats and caps, and hat and cap bodies made of leather without seam."

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7. For an improvement in the *Steam Engine;* William Whitham, Huddersfield, England, Sept. 4.

The object of this improvement is to work steam expansively in one portion of the engine, after it has acted by high pressure in another part, in direct communication with the boiler, as in the Woolf engine, except that in this engine the object is sought to be attained by one piston instead of two, so that the force of the steam, as the patentee states, is employed, "first, by high pressure, second, by expansive pressure, thirdly, by condensation." The piston, which works in a cylinder, has its upper surface reduced by a cylindrical case which surrounds, and is connected with, the piston rod, and which passes through a stuffing box in the head of the cylinder. The upper surface of the piston being thus reduced, and the whole of the under surface being retained, the steam passages and induction and eduction valves are so arranged, as to admit the steam directly from the boiler to the upper surface of the piston, and after it has forced the piston down, it is admitted to the under and large surface, and there acts by

expansion upon so much of its surface as the area of the under surface is greater than the area of the upper surface, for the rest is neutralized, the pressure being as great above as below, on equal surfaces.

Claim.—"What I claim is the combination of the peculiar piston within a steam cylinder, having suitable steam ways and slides, or valves, by which the steam, having acted by high pressure on one side of the piston, may pass into the cylinder on the other side of the piston, and act by expansive pressure on the larger area of the piston, and thus produce the return stroke of the piston, as described."

The engineer, in considering this, will wonder at the waste of ingenuity, time, and money, to effect what is so much better done by the simple cut-off now so extensively applied.

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8. For an improvement in the *Augur for Boring Artesian Wells*; William Morris, Kanawha county, Va., Sept. 4.

The object of this improvement is to prevent, as much as possible, any injury to the pole, or bar, to which the bits, or drills, used in boring artesian wells, are subjected when the bit, or drill, strikes the bottom. The bit, &c., is attached to a heavy sinker, to insure its descent, and increase the force of the blow, and the sinker is connected with the pole, or bar, by means of a sliding joint, so that when the bit, &c., strikes the bottom, the sliding joint eases the jar which the pole would otherwise receive.

Claim.—"What I claim as my invention, is the method of uniting the bit, &c., with the sinker, by means of the sliding connection, substantially as herein described."

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9. For an *Improved Apparatus for Supplying Water to Steam Boilers*; John Hampson, New Orleans, La., Sept. 4.

In the upper part of a boiler is fastened a steam pipe, with a seat for a valve that opens downwards by a lever, to which is jointed a float that rises and falls with the surface of the water in the boiler. A rod passes through a stuffing box in the upper part of the boiler, and just over that end of the lever to which the float is attached, to enable the engineer to open the valve at pleasure. By this arrangement this valve can be opened from without, but cannot be closed except by supplying a sufficiency of water to the boiler. The pipe to which this valve is attached, extends up to a small vertical cylinder open at both ends, and made fast to a steam-tight cistern, or reservoir, near the lower end, and within the cistern, the cylinder is pierced with two small holes to admit steam from the boiler to the upper part of the cistern, and near the upper end it is also pierced with another hole to admit steam to a whistle. Within this cylinder there are two pistons connected together, at such distance apart, that when the lower one is below the holes that admit steam to the cistern, the one that leads to the whistle is closed, and *vice versa*. These pistons are connected with an ordinary valve in a water-pipe leading from the bot-

tom of the cistern to a reservoir of water by two bars; the surface of the lower piston is as much greater than the valve as to have the surplus pressure on their surfaces balance and overcome the weight, friction, &c., of the moving parts. There are two hangers attached to the bottom of the cylinder that extend down to about the middle of the cistern, and sustain a bolt that guides the bars that connect the pistons and valve, and form the fulcrum of a lever "formed like a cross hilted sword," placed between the two bars—the fulcrum being at the junction of the cross. To the bolt is jointed two spring hook catches, one up and the other down, that alternately engage and hold on to studs, or pins, in the before mentioned bars, for the purpose of holding the pistons and valve up, or down, as may be required. The long end of the cross lever is forked and jointed to a collar on a float that slides up and down on a rod extending from the bottom up, and through the top of the cistern, and the short arm is provided with a counterweight which balances half the weight of the float when out of the water; and the cross arms of this same lever act on the spring catches.

The cistern communicates with the boiler by a pipe from the bottom of the former, and passing through the top of the latter, and extending down below the low water mark. In this pipe there is a valve opening downwards, and attached to a lever having a float. A discharge pipe at the bottom of the cistern is provided with a cock. The operation of this apparatus is as follows, viz.—"When the water becomes too low in the boiler, the first described float sinks, opens the valve connected with its lever, and steam passes up the pipe, and from thence into the cistern through the two holes in the cylinder, until its pressure is sufficient to force up the pistons which cut off the steam, and opens the passage to the whistle, or alarm—the lower stud pin, on the bars of the pistons, is caught by the lower catch on the cross lever, which prevents the pistons from descending. This same operation opens the valve in the water, or supply pipe, down which the steam passes, and is condensed, and then the water from the main reservoir is forced up into the cistern, by atmospheric pressure; when the supply of water in the cistern is sufficient, the float on the end of the cross lever rises, liberates the piston and valve bars from the catch, and the valve in the supply pipe is immediately closed by the pressure of the atmosphere on the upper one of the two pistons. As soon as these have descended, the upper stud pin is caught by the upper spring catch, steam is again admitted to the upper part of the cistern, which establishes a balance of pressure in the boiler and cistern, the weight of the water then opens the valve in the pipe that connects the two, and passes into the boiler. The discharge of the water from the cistern leaves the float on the cross lever suspended, the weight of which disengages the catch from the stud pins; the steam then forces up the pistons, and thus leaves the apparatus in a condition to act again.

Claim.—"What I claim is the particular manner in which I have combined the float and valve of the boiler with the reservoir and boiler, and the passages connecting them, by means of a cylinder and

pistons of peculiar construction, and the apparatus connected therewith; and also combining with the same the float and lever within the reservoir, and the tube for supplying said reservoir with water, so as to produce a self-acting apparatus both for supplying the boiler and reservoir with water; that is to say, I claim, first, the combining with the reservoir which receives the water for supplying the boiler, the connecting tube, the cylinder, the pistons, the bars, and the valve, constructed and operating substantially as set forth; second, the combining with the foregoing apparatus the float, lever, and valve within the boiler, for admitting steam into the tube on the descent of the float, the pipe for supplying the reservoir with water, and the tube for conducting it into the boiler; the whole being constructed and operating as described; third, I claim the mode of governing the supply valve, and regulating the admission of steam into the reservoir, by means of the lever, provided with a float and a counterbalance, and furnished with catches, as set forth, and combined with the bars, having studs, or pins, to which said catches are adapted, in the manner and for the purpose herein described; fourth, combining the whistle, or alarm, with the cylinder, steam pipe, and pistons, as set forth, for the purpose of giving an alarm when the water is low in the boiler."

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10. For an improved machine for *Shrinking and Napping Hat Bodies and Cloth;* Henry A. Wells, New York city, Sept. 11.

This machine consists of a double case, of a cylindrical, or other, form, hung upon journals in an appropriate frame. The hat bodies, or felt cloths, are put in the inner case, and in the commencement of the operation steam is admitted to the inside through a hollow gudgeon, so that steam is discharged on to them whilst they are worked together by the rotation of the apparatus; and afterwards this supply of steam is cut off, and steam, or heated air, is admitted through the other gudgeon into the space between the two cases. It is preferred that the inner case be polygonal, the better to work the hat bodies, or cloths, within.

Claim.—"The principle of this improvement, which I claim as my invention, consists in the mode of operation whereby the material to be shrunk, contracted, or felted, with rapidity and evenness, is subjected to the direct action of steam, and afterwards only to a dry heat in a double vessel, kept all the time in motion, so that the material may be exposed on every side to the action of the steam, or heat, during the operation, as aforesaid. It is obvious that an outer and inner vessel, of any form and dimensions, may be used, and yet the principle be the same. I have described the form I prefer; but I claim, as my invention, the use of any mechanical means operating substantially in the same mode to produce the same effect."

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11. For an improvement in the manner of *Supporting and Arranging Grates in Stoves, &c.;* Gardiner Chilson, Boston, Mass., Sept. 11.

This grate, which is represented as elliptical, and adapted to a stove

of the same form, is hung on journals placed a little to one side of the longitudinal axis, so that more than one half of the surface of the gate shall be on one side of the line running through journals. The widest side of the gate rests on two supports, or projections, from the inside of the stove, so that the coal in the grate, being more on one side of the axis of rotation than on the other, prevents it from turning, except when force is applied to one of the journals that passes through the side of the stove, and is there adapted to receive a hand lever for this purpose.

Claim.—"I claim, as my invention, extending one of the journals of the grate through to the outside of the stove, and by means of a lever inserted thereon, in combination with the projections, above mentioned, obtaining an easy process by which the ashes may be shaken, or sifted, from the coal, and the coal may be removed from the grate, while the same is entirely closed; the whole being constructed and operating, substantially as above specified."

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12. For improvements in *Salting Animal Matters;* Charles Payne, South Lambeth, England, Sept. 11.

The object of this improved apparatus is to apply brine to animal matter in an exhausted vessel. At the bottom of the receiver there is a perforated plate on which the material is put, and on the top of it is put another perforated plate. The bottom of this receiver is provided with a discharge pipe and cock, and the upper part is in connexion, on one side, with an air pump, provided with a gauge for indicating the vacuum, and on the other with the vessel containing the brine—there being an air-pump and safety valve between them. The animal material being put into the receiver, the communication with the brine vessel is closed by an air-tight cock, and that with the air-pump is opened. When a vacuum of about twenty-seven inches is obtained, the stop-cock on that side is closed, and the one leading to the brine vessel opened, and the brine is immediately forced into the receiver by atmospheric pressure. When the receiver is filled, the force pump is set to work until the required pressure in the receiver is indicated by the safety valve; the meat is then suffered to remain under this pressure for about fifteen minutes, and then taken out.

Claim.—"What I claim is the mode of preserving animal substances by means of a vessel (receiver) combined with an air-pump for exhausting it, and a reservoir containing brine, the whole being constructed and operating in the manner set forth. Also, the method of constructing the receiver with a false bottom perforated with apertures in combination with the pressure-pump, for forcing the brine through the animal matter."

(To be Continued.)

NOTE BY THE EDITOR.

It will be seen by the caption of the foregoing analytical list of American Patents, that it is drawn up Mr. C. M. KELLER, Examiner

of Patents in the United States Patent Office. Such had been the case for about eighteen months prior to suspending the publication of said lists; but animadversions were then occasionally added by the editor, in his revision of them. They will, hereafter, be published without such addition, excepting when specially noted, the whole duty of their preparation devolving upon Mr. Keller, who deems it incompatible with his official station to remark upon the merits, or defects, of the respective patented inventions. The editor is aware that this list has constituted a leading feature of the Journal of the Franklin Institute, and many inquiries have been made into the cause of its discontinuance; it is not thought necessary to enter into particulars on this subject, and it will suffice to say, that the income from the Journal has never covered the expenses of its publication; that when its fiscal concerns were transferred to the Institute, the editor had expended several thousand dollars on its establishment; and that, without taking into account the value of eighteen years labor, he has not received the amount of his actual expenditures. The Institute would willingly have paid him liberally, had it possessed the means; but it has had to divert funds, derived from other sources, to the sustaining of the Journal, and the labor now bestowed upon it by the Editor, like that of the Colaborators, and of the Committee on Publications, is given without charge. This state of things may excite surprise, as the Journal is extensively diffused; still, however, the number published is but small, compared with that of many other periodicals, a single copy being, in many instances, subscribed for by large manufacturing establishments, and deposited in their reading rooms.

It is the intention of Mr. Keller to supply, every month, an analytical list of a portion of the patents that have passed during the period that has elapsed since their publication was suspended, and to continue this until the hiatus is filled, the Institute having made arrangements with him for that purpose; and the editor will also publish many of the specifications, drawn up by him in the regular course of his business, as agent of applicants for patents.

T. P. J.

ENGLISH PATENTS.

Specification of a Patent granted to WILLIAM NEWTON, *of the county of Middlesex, for certain improvements in the preparation of Paper, designed for Bank Notes, Government Documents, Bills, Cheques, Deeds, and other purposes wherein protection and safety from forgeries, or counterfeits, are required.—Sealed June* 10*th.* 1843.

The improvements in the preparation of paper designed for bank notes, government documents, bills, cheques, deeds, and other purposes, wherein protection from forgeries is required, consist in covering both sides of the paper used for the above objects with designs,

arranged and printed in such a manner that they cannot be imitated by the hand of man, or the agency of machinery, nor transferred upon stone, and then reproduced by any of the means known in lithography.

It is a well known thing, that stamped paper used for deeds may be washed, and used again for other deeds; the government stamps being preserved unmutilated, and that part of the writing may be taken out, and other words substituted; also that figures and indications of sums of moneys may be altered by chemical processes, the stamp remaining entire, as well as the body of the document.

Now the present invention has for its object, firstly, to render it impossible to wash out any portion of the writing, and substitute other words. Secondly, to guard against any partial alteration made in the tenor, or wording, of the deed, or other document, for fraudulent purposes. Thirdly, consequently to increase the revenue of the Stamp Office, by preventing the possibility of stamped papers being used more than once. Fourthly, to give to commercial purposes all the security required.

The designs printed on the surface of the paper, and on each side thereof, must be so organized as to render it impossible, first, to imitate the matrix, or mother plate, from which the design is obtained. Secondly, to trace, or copy, by hand all the elements, or parts, of the design with lithographic ink, for the purpose of transferring it upon stone; and thirdly, to transfer the whole design on to lithographic stone, and from which proofs may be afterwards taken.

These results are attained by the improvements forming the object of the above in part recited letters patent, for the perfect intelligence of which, I shall describe the nature of the paper to be used, the designs to be employed, the mode of organizing and engraving them, the printing of the same, and the nature of the inks.

Choice of Paper.—The paper used for deeds and documents of all kinds, must be of such a kind, or nature, as to present all the requisites of durability. Two sorts of paper are manufactured, the one made by the hand, and called "hand made," the other made by a paper machine, and called "continuous, or machine made paper." The manufacturer of continuous, or endless, paper cannot conveniently use pulp, powdered by mallets, or beaters, as is the case for paper made by hand, the fibres of such pulp being too long to drain on the endless wire cloth. From hence arises the necessity of using grinding cylinders of great power, in order to convert the rags into a very fine pulp. As a necessary consequence, the continuous, or machine made, paper is of a finer quality, but is not so strong as the hand made paper.

The papers, the pulp of which has been bleached by chlorine, ought not to be used for making a safety paper, that is to say, paper presenting all the above mentioned conditions, for the chlorine weakens the pulp, and opposes obstacles almost insurmountable to the making of safety paper.

Papers manufactured in this manner, however carefully they are made, always retain certain chemical agents, which, after a time, act

upon, and eventually may possibly destroy, the vegetable substances used for coloring the inks. It is known that on some papers manufactured in the above manner, the writing becomes obliterated and illegible in a very short time.

It is, therefore, of the utmost importance in the production of safety paper, to employ only paper manufactured by hand, with rags naturally white, and not bleached by chlorine. This observation has only for its object the production of a paper of the greatest possible durability, and not containing any chemical agents likely to attack the ink; but the improved method of preparing paper for all the purposes above mentioned, may be applied to continuous, or machine made, paper, in the same manner as to paper made by hand.

Nature of the Design.—It is not sufficient that the design engraved should be difficult, or impossible, to copy, it is also necessary that any falsification may be easily detected, and that the subscriber of a promissory note, the drawer of a bill of exchange, or any one else, should be able at a single inspection of the documents, to ascertain whether the design has, or has not, been reproduced by hand, at the place where the amount of money is generally written, without being under the necessity of bringing another bill to compare therewith.

The design must, therefore, be composed of regular parts, easily perceptible, and recognizable by the naked eye; but it is essential that the type, figure, or device, be geometrically regular, and present a great purity and distinctness in the lines, and a great symmetry in the disposition of its constituent parts. In its composition there should be no straight lines, because they are too easily made with a rule, nor any curve which may be traced at once by a compass. The imitation of this regular element must oppose insurmountable obstacles to forgers.

These regular elements are to be distributed symmetrically on the whole surface of the sheet of paper, and must be repeated a great number of times, to offer a great number of points of comparison.

What has been stated with reference to the disposition of one of the regular elements taken individually, applies equally to the whole of the elements constituting the design.

It is, therefore, indispensable, in order that these regular elements may be inimitable by hand, that they should be distributed on the surface of the paper with a mathematical precision, so as to offer an uniform tint; they are, consequently, to be engraved and distributed on the surface of a matrix, or mother plate, in steel, or other metal, or on stone, by the agency of a machine. A regular element, or design, must, therefore, be mechanically produced, and repeated identically, and at regular intervals on a given surface, so that the most skilful hand, assisted by the most keen eyesight, and the most obstinate patience, will find it impossible to reproduce one of those elements if it were obliterated.

The same impossibility would exist with reference to any attempt made to charge the whole of the lines constituting the regular element with lithographic ink, in order to transfer them on to stone, and strike off proofs from the same.

The design produced in the manner above described could not be imitated by hand, but might be, by mechanical means, and as a guarantee against that contingency, I have recourse to the following contrivance:—

The spaces left between the regular elements are filled up by a design of a different aspect and description, but no confusion with the regular elements must take place; and, moreover, this design, as an indispensable condition, is produced by chance, so that it is impossible to obtain two similar drawings by using the same means, or any other; the latter design is microscopic, that is to say, the elements constituting it can only be properly seen by means of a magnifying glass. The second design produced by accident, and not imitable, has, for its object, to render the counterfeit of the matrix, or mother plate, impossible, and also the washing of stamp papers which have been written upon, and the reproduction of another design.

Organization of the Designs.—A matrix, or mother, design composed of regular elements in the condition above stated, is to be engraved by means of a point, and a suitable engraving machine, or by any other method of producing the same result capable of engraving a given device, or design, *ad finitum*, and with the greatest precision. This design may be engraved, or marked, on a lithographic stone, or even on a block of wood; but a steel plate is preferable, as this description of work requires great precision.

A proof is taken from this plate in the ordinary manner of copper-plate printing, and transferred on to the lithographic stone by the means now known and employed by lithographers. The transfer being thus made, I then, by means of a brush, and gum arabic dissolved in water, and slightly colored, or any other substance soluble in water, cover all the regular elements constituting the design transferred on to the stone. This covering, which is not applied over the intermediate spaces left between the regular elements of the design is allowed to dry. Then a second drawing is transferred on to the whole of the same stone, this latter drawing being composed of irregular elements much smaller than the regular elements of the first drawing, and which may be microscopic.

It will be understood that the regular elements being protected by the gum covering, and the intermediate spaces alone being left, it is only on the latter parts that the stone will receive the second drawing.

This drawing is previously to be made on a sheet of metal, or stone, or even on wood. It may be etched and engraved by the hand, by machinery, or by a chemical process; but whether made on a metal plate, on stone, or by a lithographic operation, it must necessarily be obtained by chance, so that it cannot be reproduced, either by the process that effected it, by any other process, or by the hand of an artist.

I shall point out, by way of illustration, some of the means which may be employed to attain this result.

One may take resin, or colophony, in powder of a middling fineness, and sift it on to a lithographed stone previously heated. When the grains, or atoms, of resin are fixed by the heat, the stone must be

corroded by a solution of nitric acid, and thus an irregular ground is obtained.

The size of the grains of resin, the degree of heat necessary to be given to the stone, in order to fix the said grains, as well as the strength of the acid employed for the corrosion, must vary according to the results to be obtained.

One may also make an irregular ground on a lithographic stone, by taking a brush with short hairs, or bristles, dipping this brush in thickened lithographic ink, and striking gently, or irregularly, on the surface of the stone with the extremity of the brush, the ink thus laid on the stone is to be fixed by the ordinary process.

One may also cover a lithographic stone with lithographic ink, which is allowed to dry, then, on the whole of the blackened surface, an engraver's roller is to be rolled irregularly to obtain white points on a black ground.

The above are only a few of the many modes which may be employed to produce an irregular ground.

It must be understood that the owner of this plate may take proofs from the same, transfer them on to stone that he may take casts from it, cause it to be reproduced by the polytype and electrotype process; but neither the author himself, nor any other person, could make a second plate identical with the first, except by some of the above means of multiplication.

The irregular ground being obtained by one of the modes above stated, or some mode equivalent, I take a proof from the plate, and transfer it on to the lithographic stone which has received the regular drawing, as above stated.

The transfer being made and fixed on the stone, I remove the gum by which the regular elements have been covered, and then I can have lithographic impressions, on which may be distinguished, by the naked eye, the regular elements surrounded, but not covered by irregular and microscopic elements.

Instead of composing the matrix, or mother plate, by transfer taken from two separate plates, this object may be effected by executing on the same plate on which the regular design has been already engraved, and by any of the means above indicated, or by any other appropriate mode, the irregular design forming the ground, so as to obtain a mother plate without transfer.

The matrix, or mother plate, thus obtained, twenty, or a greater number of plates should be produced, in order to guard against any accident which might happen to the matrix, or mother plate.

These plates, which I shall call *seconds*, are obtained by taking proofs from the mother plate, transferring them on to stone, and fixing them thereon.

From the *seconds* impressions are taken, and that may be done *ad infinitum;* these proofs are transferred on to lithographic stone, the lineaments are brought up in *relievo* by the ordinary process of engraving upon stone, and then the impression may be produced by the typographic press.

I have now described the improved mode of producing the visible

design which cannot be imitated either by hand, or by machinery, I shall now state by what means I prevent any impression of these drawings from being transferred on to stone, and afterwards multiplied at will. In order to make this perfectly intelligible, I must describe the inks I use, and the mode of employing them.

Inks, and mode of using them.—The arts of imitation have lately made an immense progress. Clever lithographers transfer on to stone, not only old impressions of type and engravings, but also old manuscripts, and every kind of printing made of delible, or indelible, inks, either oily, resinous, or watery. It cannot, therefore, be considered a wonder, that scientific men look upon it as impossible to create a safety paper which can neither be imitated, nor transferred upon stone.

I have solved the first part of the problem by the improved system of drawings, or designs, and I render it impossible to transfer the impressions by means of the inks I am going now to describe.

I prefer delible inks made with a mixture of oil, gum, or resin, because they are more easily employed in typographical impressions. I make a certain quantity of white ink, composed of balm, capahu, Venetian turpentine, and chalk previously washed and dried. These substances are ground together until they are brought to the consistency of ordinary printing ink. I call this ink No. 1. I take one-half of it and set it aside; in the other half I introduce a sufficient quantity of ordinary ink, reduced to powder by evaporation. This is done in order to give the necessary coloring, that the design to be printed with this ink may be visible to the naked eye, and, at the same time, that the writings made on the prepared paper may be perfectly apparent. This second sort of ink I call ink No. 2.

Instead of dried ink for coloring the ink No. 2, I may use any other coloring substance which is equally delible, or as easily obliterated as common ink powder, in order that any attempts to extract part of the writing formed on the paper may cause the extraction, or obliteration, of the visible design printed on the paper with this delible ink.

An impression is made on both sides of the paper with ink No. 1, and to effect this, old plates, and those which are defective, are suited to this first impression, which, not being visible, need not be made with plates free from defects.

The visible design is then printed with ink No. 2. This latter impression is made with all possible care, and, consequently, with lithographic stones engraved, or prepared, with great precision and care. After these two impressions the paper is dried, pressed, and cut, and shaped for use.

It is not necessary to make these two impressions on two distinct presses; they may very easily be executed by means of a single printing machine with two cylinders, but their details form no part of the present invention, and are foreign to the system of safety paper.

A very good ink for printing the visible design may be made as follows:—

1. Chalk well washed, . . . 20 to 25 parts.
2. Common ink reduced to powder, or by preference, gallate of iron. . . . 4
3. Ultra marine blue, ... 1

Varnish, ... *quantum sufficit.*

This varnish, as well as the one above stated, is composed with equal parts of balm of capahu and Venetian turpentine, melted together, and to be used when cold.

Results of the new combinations of Inks, and of the double Impressions.—If a forger attempts to extract a word, or a sentence, or any quantity of writing formed on the safety paper, presently described, he will begin to use chlorine; this agent will destroy the color of the writing, and that of the visible impression, the coloring principle of ink No. 2, being the same as that of ordinary ink. He then will use an acid to remove the oxide of iron, which will still leave traces in the place of each letter, and each lineament of the visible design, which traces cannot be obliterated by chlorine. In this second operation the acid will have destroyed also the chalk contained in ink No. 1, and ink No. 2.

The safety paper, thus treated, will retain at the spot obliterated only the slight marks produced in the substance of the paper by the pressure of the two impressions, and the resinous principles of the two inks employed, for no vestige will remain of the ink with which the writing was formed.

But neither the slight marks left in the paper by the printing of the visible design, nor the vestiges left by the resinous varnish of ink No. 2, will be of any use to the forger in his attempt to reconstruct the design at the place obliterated. To the marks made by the printing of the visible and invisible designs, and the vestiges of the resinous principles left on the paper by the inks No. 1 and No. 2, will be so complicated, and so much worked into one another, that it will be impossible to distinguish any thing.

If, moreover, the conditions of the designs, or the principles upon which they are constructed, are referred to the numerous points of comparison which the same piece of paper will naturally offer, the perfection of the part executed by machinery, the impossibility to imitate by hand, or machinery, the part executed by chance, every one will be convinced that the reconstruction of part of the design will be utterly impossible, and the reproduction of a design by a lithographic transfer will be equally impossible.

In fact, whatever be the process employed to transfer the design on to stone, it will be impossible not to transfer at once the two designs, the visible and invisible one, as both are printed with a resinous ink at the same moment, and the only substance which dintinguishes the two printing inks, is a small quantity of dried ink powder, which can have no influence on the transfer, being mixed with a resinous body, which is more readily transferred on to stone than itself.

By counterproofing the design of our safety paper, the forger, instead of finding on the stone the design he expects, will find a surface perfectly black, or presenting a confusion produced by the instanta-

neous transfer of the two designs, which may be identical, but are not placed one on the other in their proper places.

I consider that this system of drawings, consisting of small designs, both delible, the one visible, the other invisible, answers all conditions that are required, and presents to government, trade, and private individuals, a most complete guarantee. It must be understood, that the receipts of inks which we have given are only for the sake of illustration, and that other combinations of appropriate ingredients might produce an analogous result.

The system of preparation of paper for the purposes set forth in the title of the patent being now fully described, I wish it to be understood, that I do not intend to limit myself to the making of designs which will appear in colored lines on a white ground, as I may also produce designs according to this system which will appear in white on a colored ground.

That I may use, for the printing of the visible design, inks of any composition having the qualities above set forth, though I give preference to the kind of ink above stated.

I claim the covering of paper intended for all the purposes indicated in the title of the patent, with two designs composed of elements regular and irregular, and obtained by the means hereinbefore described, one of the designs being printed in visible ink, and the other in invisible ink, both these printings being delible, by employing which means it will be found impossible to re-constitute, or re-construct, the design, of which part has been extracted by chemical agents, and an equal impossibility of transferring the whole design on to stone, in order to multiply it at will, by impressions taken therefrom, and thus a complete guarantee is given to government, to trade, and all private transactions.—*Enrolled December 9th*, 1843.

Lond. Journ. Arts & Sciences.

Specification of a Patent granted to Thomas Drayton, *of Brighton, in the county of Sussex, for improvements in Coating Glass with Silver, for looking-glasses, and other uses.—Sealed 25th November*, 1843.

A mode of silvering glass, for looking-glasses and other uses, without the employment of quicksilver, constitutes the subject of this patent; it consists in depositing silver, from a solution, upon glass, by de-oxidizing the oxide of silver in solution, in such a manner that the precipitate will adhere to the glass, without the latter having been coated with metallic, or other substances.

A mixture is first made of one ounce of coarsely pulverized nitrate of silver, half an ounce of spirits of hartshorn, and two ounces of water; which, after standing for twenty-four hours, is filtered, (the deposit upon the filter, which is silver, being preserved,) and an addition is made thereto of three ounces of spirit, (by preference, spirit of wine,) at 60° above proof, or naptha; from twenty to thirty drops of oil of cassia are then added; and, after remaining for about six hours

longer, the solution is ready for use. The glass to be silvered with this solution must have a clean and polished surface; it is to be placed in a horizontal position, and a wall of putty, or other suitable material, formed round it, so that the solution may cover the surface of the glass to the depth of from an eighth to a quarter of an inch. After the solution has been poured on the glass, from six to twelve drops of a mixture of oil of cloves and spirit of wine (in the proportion of one part, by measure, of oil of cloves to three of spirit of wine,) are dropped into it, at different places; or the diluted oil of cloves may be mixed with the solution before it is poured upon the glass: the more oil of cloves used, the more rapid will be the deposition of the silver; but the patentee prefers that it should occupy about two hours. When the required deposit has been obtained, the solution is poured off, and as soon as the silver on the glass is perfectly dry, it is varnished with a composition formed by melting together equal quantities of bees'-wax and tallow. The solution, after being poured off, is allowed to stand for three, or four, days in a close vessel; as it still contains silver, and may be again employed after filtration, and the addition of a sufficient quantity of fresh ingredients to supply the place of those which have been used; the patentee states, that, by experiment, he has ascertained that about eighteen grains of nitrate of silver are used for each square foot of glass; but the quantity of spirit varies somewhat, as its evaporation depends upon the temperature of the atmosphere, and the duration of the process.

If the glass be placed in an inclined, or even a vertical position, and the surface covered over, leaving a narrow space for the solution between the surface of the glass and the cover, which fits close, then, by using spirit without water in the mixture, the object will be accomplished. By the addition of a small quantity of oil of carraway, or thyme, the color of the silver may be varied. The oil of cassia, purchased of different manufacturers, varies in quality; therefore, if, on being mixed with the solution, it should become flaky, the solution must be filtered previous to use.

The patentee, in concluding his specification, says, that he does not confine himself to the precise details herein described, provided the peculiar character of the invention be retained, whereby silver is deposited on to glass from a solution of that metal, by deoxidation, in such a manner as to cause the silver to adhere to glass, without any previous coating of the latter.—*Enrolled in the Enrolment Office, May*, 1844.

Ibid.

MECHANICS, PHYSICS, AND CHEMISTRY.

Extracts from the Report of Capt. G. W. Hughes, *of the Topographical Engineers, to the Secretary of War, relative to the working of Copper Ore.*

(Continued from page 133.)

Swansea is the greatest manufactory of copper in the world; and

here, nineteen-twentieths of the copper of the kingdom is made. All the ores here reduced, are brought from a distance—some from Valparaiso, some from Cuba, a small quantity from New Orleans, and a large proportion from Cornwall and Devon, and some, but not a great deal, from Holyhead, Anglesea, and from Ireland. It is now 250 years since the first ores were shipped from Cornwall to Wales. The Cuba and South American ores yield about 20 per cent., sometimes, but rarely, 25; the Irish 10 to 12; and the Cornish 7½ to 8½. I could learn but little about the ores from the United States, except that they were pretty good. Ores yielding 20 per cent. of copper are worth, at the furnaces, *when prepared for smelting*, from £18 to £20 per ton, or between $90 and $100 per ton of 21 cwt.* The best metal is worth from £100 to £120 per ton, and the profits are said to be large.

The following table (extracted from the official report of Mr. De la Beche, director of the Ordnance geological survey,) of the foreign and British ores, sold to the proprietors of the Swansea works, by ticket, in the manner practiced in Cornwall, may be useful in showing the amount of foreign copper ore imported into South Wales, during the year ending 30th June, 1838, as also the produce of some of the copper mines in Ireland and Wales, for the same time:—

	21 *cwt.*	£	*s.*	*d.*	£	*s.*	*d.*
Allikies,	4,575	43,436	6	6	9	9	10
Ballymurtagh,	6,711	21,840	16	0	3	5	1
Ballygahan,	634	2,322	10	6	3	13	3
Chili ores,	5,619	115,915	1	6	20	12	7
Cobre mines,	5,644	114,406	15	6	20	5	4
Copiapo,	1,047	19,475	9	0	18	13	4
Cuba,	1,133	20,604	11	0	18	3	8
Cronbane,	2,056	7,499	19	0	3	12	11
Connore,	350	1,552	9	6	4	8	8
Crom,	23	194	7	0	8	9	0
Drwsycoed,	400	2,332	17	0	5	16	7
Knockmahon,	6,345	53,561	10	0	8	8	9
Llandidno,	811	6,909	17	6	8	10	4
Llanbenis,	494	2,083	6	6	4	4	4
Llandegai,	66	469	2	0	7	2	1
Laxey,	137	513	9	0	3	15	0
Mexican,	90	797	13	0	8	17	3
Norway ores,	1,591	18,303	7	6	11	10	0
Penralt,	74	494	18	6	6	13	9
Symnia dylluan,	186	1,425	0	6	7	13	2
Sygun,	183	728	19	6	3	19	8
Sundries,	362	1,780	1	0	4	18	4
Tygrony,	2,034	9,354	18	6	4	12	0
Union,	446	1,460	9	0	3	5	5
Valparaiso,	1,920	33,859	14	0	17	12	8

Average standard £97 17*s.* Average produce 14¾. Average price per cwt., £11 4*s.* 6*d.* Fine copper, 5,906 tons 9 cwt. 2 qrs. 25 lbs. Amount of money, £481,323 3*s.* Copper ore, 42,931.21 cwt. The amount of copper ore thus sold in Cornwall and Swansea, for the year ending, as above, would amount to 188,619 tons, (of 21 cwt.

* This, of course, varies with the standard value of fine copper.

each,) estimated to contain 17,433 tons of fine copper, and sold for £1,339,102 14*s.* From another source, I have ascertained that the amount of copper ore smelted at Swansea, from 30th June, 1839, to 30th June, 1840, was 203,545 tons of 21 cwt. Produce in fine copper, 19,511 tons 1 cwt. 3 qrs. 24 lbs., worth £1,466,770 7*s.* 6*d.*

Copper ore imported into the United Kingdoms, for the year ending 5th January, 1840, 28,757 tons. Average value of Cornish ores, in the year ending 30th June, 1840, £5 7*s.* 6*d.*

Average value of Cuba ores, for the year ending June 30th, 1840, £14 12*s.* 4*d.*

Average value of Cobre ores, for the year ending June 30th, 1840, £16 10*s.* 3*s.*

Average value of Chili ores, for the year ending June 30th, 1840, £19 4*s.* 0*d.*

Average value of Valparaiso ores, for the year ending June 30th, 1840, £19 7*s.* 3*d.*

The foreign copper ores are merely introduced for the purpose of smelting, and the purchasers of such ores are bound to export as much copper as is estimated, from assays made previous to sale, to be contained in them; hence the quantity necessary to be exported depends on the accuracy of such assays.

The amount of metal procured from foreign ores is sometimes nearly, or quite, one half of the entire reduction; but, for a few years past, it has greatly diminished, owing to some failure, or difficulty, in working the mines, or, perhaps, to the disturbed political condition of the South American States. In 1837, it was nearly one-third of the whole reduction. Copper pyrites, or the *bi-sulphuret* of copper, is the chief ore of that metal which occurs in Devon and Cornwall, other copper ores being found in comparatively small quantities. The next in importance is the *sulphuret*, or *gray*, ore of the miners. The *black ore*, or oxide of copper, is sometimes found in sufficient quantities to be worked to advantage. The carbonates are rich, but are seldom used except when mixed with the other ores, owing to the tendency of the metal to escape with the liberated volatile matters they contain. The escape of carbonic acid gas carries with it much of the metallic base, in a state of sublimation.

It is thought that nearly all the metal from the ore is extracted, not losing more than a half per cent. beyond the assay; but it is not clear that they obtain all that chemical analysis would show. The assay is usually by the *dry mode*, and analogous to the process of reduction on a large scale.

Tin, Tin Ores, and their Reduction to a Metallic State.

Tin is a metal of a yellowish white color, considerably harder than lead, but less so than gold, very malleable, but not tenacious. Hence wire cannot be made of it; but under the hammer it may be extended into very thin leaves, called *tin foil*, less than the one-thousandth of an inch thick. It exhales by heat a peculiar sweetish odor, and may be recognized by a crackling noise when bent. Its specific gravity, when pure, (in which state it can seldom be found, as it is

not often obtained pure from the ores, and when so, is generally adulterated afterwards with lead,) is 7.290.* It melts at 442° of Fahrenheit.

This metal has been known from a remote antiquity, and it seems to be well ascertained that the Phœnicians traded to Cornwall for tin long before the conquest of Britain by the Romans.

It is still a matter of much doubt whether *native tin* has ever been discovered. Magellan says he has, *undoubtedly*, found it in three different states: 1st, malleable in a granular and foliaceous form, imbeded in arsenic; 2nd, in crystaline lamina, or flat crystals; 3rd, in a massy form, more than an inch thick in some places, and enclosed in a stone resembling quartz, which was believed to be a hard crust of crystalized arsenic.†

It is generally believed, however, that this metal exists naturally in but two forms; that is, as a peroxide, or tin stone, and as a sulphuret, or tin pyrites. The latter is rather a rare mineral, the former being the only combination of tin worked as an ore.

Tin ore is seldom found in workable quantities. Its principal localities in Europe, are Cornwall, Bohemia, and Saxony; and in Asia, Malacca and Banca. When found *in situ*, it is always in the most ancient rocks. It does, however, often occur in alluvial deposits, being, no doubt, the detritus of broken down lodes.

The mode in which the tin ore occurs in lodes associated with ores of copper, and of other metals, and in *stockwerkes*, or strings, running along the divisional planes of certain granites where it is found with schörl, has been already described. It often forms "bunches" in the lodes, similar to the patches of copper ore before mentioned. It is sometimes extracted from the gossan accompanying copper lodes, and often occurs in the copper lodes.

The oxide of tin has but little of a metallic aspect, and some specimens of it none whatever. In some cases it is so minutely disseminated, that it can be detected only by the experienced eye of the miner, or by its great specific gravity, which ranges between 6.3 and 7.00. Its most usual color is a *dark liver brown;* it occasionally slightly resembles blende, and presents a resinous appearance. It has the hardness of felspar, and gives fire with steel. Its structure is imperfectly foliated.‡ It is found amorphous, in rolled masses, in grains, and often in crystals, whose primitive form appears to be an octahe-

* Few chemists have agreed as to the specific gravity of tin, owing to the difficulty of obtaining it pure. Dr. Cooper took the *best grain tin* he could procure, melted it, and allowed it to cool very slowly. He then ascertained its specific gravity to be 7.170

Ure and Cleaveland stated it to be, as in the text,	7.290
Cotes, Ferguson, and Emerson, at	7.320
Bœrheave's Chemistry,	7.321
Musschenbroeck and Wallerius, at	7.471
Martin,	7.550
The specific gravity of pure lead is about	11.380

† Emporium of Arts and Sciences, vol. iii, (new series.) Cortes states, in his despatches to the Emperor Charles V., that he found *metallic tin* amongst the Mexicans. As it is not probable that they were acquainted with the art of reducing metallic ores, may not this have been *native tin?*

‡ Cleaveland's Mineralogy.

dron, or double four-sided pyramid, with square bases. Its general secondary form is a rectangular four-sided prism, whose edges are liable to truncation, or bevelment. Before the blow-pipe it decrepitates, and its powder, strongly heated on charcoal, may be reduced to metallic tin; it is often contaminated with copper, arsenic, and iron. A specimen from Cornwall yielded Klaproth tin 77.50; oxygen 21.5; silex 0.75; iron 0.25. A specimen from Schlakenwold gave him, tin 75.0; oxygen 24.00; iron 0.50. Lampardins obtained from a Bohemian sample, tin 68; oxygen 16; silex 7.00; iron 9.00. Dr. Thompson gives the following as the constituents of a crystaline reddish brown ore from Cornwall, the specific gravity of which was 6.945; peroxide of tin 96.265; silex 0.750; peroxide of iron and sesqui oxide of manganese 3.395.

Sulphuret of tin has been rarely found out of Cornwall, so far as I am informed. Its color is steel gray, more, or less, mixed with yellow. It is never crystalized. Its specific gravity is between 4.35 and 4.78. According to Klaproth, it contains, sulphur 25, tin 34, copper 36, 2 of iron, and 3 of stony matter. A specimen analyzed by Professor Johnstone, of Durham, gave, tin 31.618, copper 23.549, zinc 10.113, iron 4.79, sulphur 29.929. It was first discovered by Raspe, in Wheal Rock, St. Agnes, Cornwall, who proposed to call it *bell-metal ore*. It is probably a mixture of sulphuret of tin and copper pyrites, the zinc and iron being accidentally present.

The first tin worked in Cornwall, was the *stream tin*, as the ore found in alluvion is called. The lodes, or veins, were discovered by following up the course of the stream tin. Much of this kind of ore is crystalized, often in hemitrope crystals, and sometimes is pseudo morphous crystals of felspar. It is, no doubt, brought from the lodes, but seems to have undergone some purifying action, as it is free from many of the deleterious substances that are found mixed with the vein ore; from it is obtained the *grain tin*, which is of the very best quality. It would appear, from the pseudo-morphous crystals, that the stream tin had been, at one time, in a state of solution. The working of the alluvion tin is extremely simple, the ore being separated from the earthy matter, with which it is surrounded, by the action of running water. The stream tin from Pensagillis, is remarkable on account of the native gold occasionally found in it; sometimes, although rarely, in pieces of the value of two, or three, pounds sterling. The most important deposites of *alluvial tin*, occur in the vicinity of St. Just and St. Austill. I have seen miners working the stream tin extensively on the sea-coast, between Marazion and Penzance.

The *mine tin* is seldom pure, and requires much care in the mechanical dressing of it, to separate it from the foreign substances with which it is combined.

The *block tin*, or the most common tin of commerce, is procured from this source. In consequence of the great specific gravity of this ore, water is extremely useful in its preparatory dressing. After having been carefully washed, by agitation in running water, it is sorted by hand into four lots: 1st, stones rich in tin; 2nd, stones con-

taining tin and copper; 3rd, copper ore; 4th, steril fragments, composed of vein stone, with iron and arsenical pyrites.

The tin ore is then ground, generally by water-wheels, in cast-iron hoppers, (having been previously broken by hammers into convenient fragments,) and is next stamped to the size of fine sand, with water running over it during the operation; it is then removed to long shallow vats, where it is *buddled*, by passing a current of water over the ore arranged on an inclined plane, similar to the mode of treating copper ores already described. The upper, or heavier, portion is the best, and is separated from the tail of the trough, where the finer and lighter portions of ore are deposited, mixed with sand. This portion is re-submitted to the same operation, by being carried to another trough, or buddle, where the water is only gently agitated over it by means of hoes. The head of the buddle, in this case, is taken to tables, so placed, that water may be passed over them, and the ore being constantly stirred, the current carries off the light, or earthy, matter, leaving the peroxide of tin in a more, or less, pure state. After this washing process has been completed, the tables are suddenly turned over, and the contents emptied into a receptacle partly filled with water.

After the ore has been sufficiently washed, to leave it nearly free from earthy matter, it is carried to the calcining furnaces, for the purpose of dissipating the volatile substances it contains, and of oxidizing the iron and copper, in order that they may, by being thus rendered specifically lighter, be removed by a rewashing. When those metals exist in considerable quantities, it is next to impossible to get entirely clear of them, as will appear in the sequel, although their presence is certain to deteriorate the character of the tin; which, however, does not injure the copper ores, but, on the contrary, sometimes adds to their value.* When the ores are refractory, they are restamped, rewashed, reheated, and again washed, before they are fit for assaying. When the tin ore is unmixed with much iron, or copper, it is not calcined, but is carefully rewashed in the refining house before smelting. The preparation of the tin ore becomes much more difficult when it contains *wolfram*, (tungstate of iron and manganese,) the specific gravity of which is rather greater than the pure ore.

Tin ores, like copper ores, are, at present, generally sold by the "*ticketing system.*" Formerly they were reduced on shares.

The Cornish mode of assaying tin ores consists generally in taking two ounces of black tin, or tin ore, and adding to them a flux composed of culm, about one-third the weight of the ore, and of borax 4 dwts. If the ore contain much iron, more culm is added. This being exposed to a strong heat, a button of tin is obtained, the value of which is estimated by its properties under the hammer. The scrapings of the crucible are usually washed, to search for any tin which may be in them.†

Another method, recommended by Dr. Cooper, and, perhaps, a better one, is the following:—

* Sometimes called "bell-metal" ore.

† De la Beche.

Pound the ore; separate it from the stony matters that accompany it; take a small piece of ore, and roast it on charcoal with the blow-pipe; if any sulphurous, or arsenical, fumes should arise on this trial, the pounded ore must be well roasted, previous to fusion, with a little charcoal; if no such vapors appear, the roasting may be dispensed with. Take 400 grains of the ore; smear the sides of a crucible with charcoal, and put a small quantity of charcoal dust in the bottom; mix up the pulverized ore with pitch and saw-dust; lute a cover on the crucible, then urge it with a fire quickly raised, during fifteen minutes, in an air furnace, or blacksmith's forge, at the end of which time the metallic tin will be found at the bottom of the crucible.

For more exact, satisfactory, and scientific assays, see Bergman, Klaproth, and especially Berthier, (Traité des Essais par la Voie Sèche, tome ii.)

All, or the greater part, of the Cornish tin ores are reduced in Cornwall.* The principal works for this purpose are at St. Austill, Penzance, Truro, and Redruth. The furnaces I visited belonged to the Truro Company.

The ore (prepared as already described,) is mixed with charcoal, and placed in a reverberatory furnace, and the flame of burning *culm* (fine anthracite) is passed through it for six hours, when the melted metal is drawn off at one aperture, and the cinders at another; a small quantity of lime is sometimes added, for a flux. The melted tin is carried in cuvettes, and poured into iron moulds, from whence it is taken, when cold, to the refining furnace, and again melted; but not in contact with the flame. It is, in fact, a liquation, the tin running out of the pigs into a receptacle below the hearth of the furnace, on which it leaves a mixed residuum of iron, copper, &c. The liquated metal is then drawn off into a large caldron, in which have been previously arranged several pieces of carbonized wood, saturated with water, to produce ebullition. This process separates the dross, which, floating on the surface, is skimmed off. The boiling, or effervescence, is so strong that it requires a weight of 300 pounds to retain the standard, to which the wood is attached, in the caldron. When the tin ore contains much iron, a piece of sheet-tin (tinned iron) is put into the refining furnace, to assist the separation of the metals.

The refined tin is dipped out of the caldron by ladles, and is run into shallow granite troughs, which form it, by cooling, into truncated pyramids, weighing nearly 400 pounds. The refining operations require from 5 to 6 hours' time; an hour to fill the basin, three hours to boil the tin with the green wood, and from one to two hours for the subsidence. The first dippings are the purest; and the last are so much alloyed with foreign matter, that they must be again refined.

The refined tin is generally separated into three divisions, according to its quality; 1st, *grain tin*; 2nd, *refined tin*; 3rd, *common tin*. The first is very nearly pure tin, and is generally obtained from the *stockwercke*, or *stream, tin ores*. The second contains copper and iron; and the third a considerable proportion of both, and some-

* The exportation of tin ores from Devon and Cornwall is prohibited by law.

times lead, purposely added. The presence of iron is less objectionable than copper. Each of the above divisions is again divided into first and second qualities. The first class, or *grain tin*, is employed for the more important alloys and amalgams; the second, for tinning iron, and for dyeing; and the third, for common solders.

The stream tin ores, and sometimes the better class of mine ores, when it is desirable to obtain a metal of unusual purity, are reduced in *blast furnaces*, or blowing-houses, as they are called, with charcoal. And this, indeed, was the ancient method of smelting all ores of tin.

Doctor Ure says:—"On making a comparative estimate of the expense by the *blowing-house* process, and by the *reverberatory furnace*, it has been found that the former yields about sixty-six per cent. of tin in smelting the stream, or alluvial, ore, whose absolute contents are from seventy-five to seventy-eight parts in the hundred. One ton of tin consumes a ton and six-tenths of charcoal, and suffers a loss of fifteen per cent. In working with the reverberatory furnace, it is calculated that ore, whose mean contents, by an exact analysis, are seventy per cent., yields sixty-five per cent. on the great scale. The average value of the tin ore, as sold to the smelter, is £50 per ton; but it fluctuates, of course, with the market prices. One ton of tin obtained from the reverberatory furnace costs—

One ton and a half of ore,	£75	00*s.*	0*d.*
One ton and three-quarters of coals,		17	6
Wages of labor, interest on capital, &c.,	3	00	0
	£78	17	6

"On comparing these results with the former, we perceive that in a *blowing-house* the loss of tin is fifteen per cent., whereas it is only five per cent. in the reverberatory furnace. The expense of fuel is likewise much less, relatively, in the latter process; for only one ton and three-quarters of coals are consumed for one ton of tin; while a ton and six-tenths of wood charcoal are burnt to obtain the same quantity of tin in a *blowing-house;* and it is admitted that one ton of wood charcoal is equal to two tons of coals in calorific effect. Hence, every thing conspires to turn the balance in favor of the reverberatory plan. The operation is also in this way simpler, and may be carried on by itself. The scoriæ, besides, from the reverberatory hearth, contain less tin than those derived from the same ores treated with charcoal by the blast, as is done at Altenberg. It must be remembered, however, that the grain tin obtained by the charcoal process is reckoned to be finer, and brings a better price—a superiority partly due to the purity of the ore reduced, and partly to the purity of the fuel."

For more than six centuries, the tin, after being smelted, was carried to certain towns, called "Stannary towns," to be assayed, for the purpose of ascertaining the quality of the metal. It was then stamped with the Duchy seal, the dues paid to the Earls, or Dukes, of Cornwall, and the blocks permitted to be sold. The average yearly revenue to the Crown, from 1820 to 1838, was, from this source, between

£11,000 and £12,000. By an act of Parliament of August 16, 1838, the duties paid on coinage were abolished, and a compensation, in lieu of them, paid to the Duchy; and at the same time the duties on the importation of foreign tin were reduced, and fixed at fifteen shillings per hundred weight for tin, and ten shillings per hundred weight of tin ore.*

Before the passage of the act of 1838, each block of tin was coined, according to Borlase, in the following manner:—"The officers appointed by the Duke of Cornwall assay it, by taking off a piece of one of the *under* corners of the block, partly by cutting, and partly by breaking; and, if properly purified, they stamp the face of the block with the Duchy seal, which stamp is a permission for the owner to sell, and, at the same time, an assurance that the tin so marked has been properly examined, and found merchantable." This rude mode of assay was founded on the supposition, that if the tin had been adulterated with lead, the foreign matter would, owing to its greater specific gravity, sink to the bottom. In foreign countries, the English stamp was often counterfeited; and, it has been said, "in Holland every tin founder has English stamps, and, whatever his tin be, the inscription '*block tin*' makes it pass for English." It is asserted that much of the Dutch tin contains nearly one-tenth of its weight of lead.

From midsummer of 1837, to midsummer of 1838, there had been coined, in Devon and Cornwall, 5,130 tons of tin, of which 1,545 was *grain tin*, and the remainder common tin. The quantity of tin imported into Great Britain, in the year ending January 5, 1838, was 1,451 tons, and the quantity exported, during the same interval, was 1,465 tons—leaving the English production of that year for British consumption.

Mr. De la Beche, in a note to his elaborate and valuable report on the Ordnance Geological Survey of Great Britain, submits the following estimate of the annual produce of British mines, which may prove of some interest to the general reader:—

Iron, at	£8,000,000
Copper, at	1,200,000
Lead, at	920,000
Tin, at	390,000
Manganese, at	50,000
Silver, at	30,000
Zinc, at	7,000
	10,597,000

If to the above sum, for metallic produce, we add £9,000,000, as the value of coal raised at the pit mouth, and about £400,000 for that of salt and other minor substances, we should have £20,000,000 as the annual value of the mining produce of Great Britain and Ireland.

To be Continued.

* De la Beche, Ordnance Geological Survey.

Improved Blast-Furnace Hearth.

A correspondent of the *Monmouthshire Merlin* writes:—"I forward you a brief sketch of a blast-furnace hearth, which I have lately seen at the works of the British Iron Company, near Pontypool. It exhibits some variation from the usual mode of construction, and appears to me to be worthy a notice in your columns. The hearth and boshes of blast furnaces are generally formed of a coarse grit, or conglomerate, popularly known as the 'plum pudding stone.' These are procured in blocks of enormous size, and, when fixed in their place, jointed with fire clay, in order to resist the action of the intense heat to which they are exposed. These stones having frequently to be brought from a considerable distance, and the dressing also requiring much labor, the expense attending this mode of construction is, consequently, very great; and, of late, some hearths have been built of fire bricks. This plan is, of course, much more economical as regards the first construction, but is not so durable as the older and more popular method. Now, in the case to which I allude, as an improvement on both of the above-mentioned modes, the durability of the former seems to be attained, while the expense of erection is even less than in the latter; and this is effected by the use of common stones, and of ordinary size. The stone employed for the purpose was millstone grit, which was selected with as little silex as possible; and the hearth was built in the following manner—the bottom was first formed with burnt brick, 2 ft. 1 in. long, 9 in. wide, and 4½ in. thick, laid on their ends and cemented with fire-clay. Over this pavement a bed of sand was placed, in which the first course of stones, forming the face of the hearth, was laid—these stones being rough-polled, and the joints well rammed with sand; and in this manner the mason work was continued to the top of the hearth. The stones were used without any attention to their size, and perfectly rough, the hatchet end of the hammer, not even being used to dress them, this plan being pursued, I should suppose, with the impression that the cinder on which the furnace was 'blown in,' would adhere better to the sides of the hearth, in consequence of such roughness. The outer casing of the hearth was formed of fire-bricks, laid in fire-clay. The dimensions of the hearth are as follows:—At the bottom, internally, 4 ft. square, and at the top, 5 ft. 8 in., the batter in the sides being 1½ inch to a foot, and the extreme size of the hearth 12 ft. square. The furnace was worked with blast-furnace cinder for about a week, and has answered extremely well, although it was the impression at the time, even of a very intelligent man engaged in its erection, that the plan would not be attended with success. The opinion, indeed, was, that no cement having been used in the work, the stones being simply bedded in sand, they could not possibly adhere together, or, to use the words of the person above alluded to, would all 'swim about,' in the fiery metal. The cinder employed in the first instance has, however, undoubtedly had the effect of forming 'a glaze,' over the hearth, and cementing the masonry into one firm and compact mass. Permit me to make one more observation, in conclusion. I have frequently heard

it remarked that blast-furnaces are sometimes a considerable period before they arrive at a good workable condition—in short, supposing the furnace be not constructed upon correct principles, it will not work to a good yield, until it has, by its own efforts, so modified the form of the different parts, as to adapt them to the peculiar circumstances of the case, by adding in one place, or removing an obstacle in another. Taking a hint, then, from these facts, would it not be advisable—at all times, whenever possible—to make an examination of a furnace which has been found to answer well, at any particular work, and to adhere strictly to the form which it has assumed in the progress of working, as that which is best adapted to the nature of the materials employed?"

Lond. Min. Journ.

On a curious Change in the Molecular Structure of Silver. By Robert Warington, *Esq.*

The subject of the present brief communication was put into my hands by my friend, Mr. Porrett, after our last meeting, as bearing on the subject of the memoir which I had the honor of reading before the Society in January, 1842; a subject I am still prosecuting, as my time will permit, and the results of which I hope to lay before the Society at an early date.

It appears, from information furnished me by Mr. Porrett, to have been part of a silver funeral vase, and was discovered by some laborers, about four months since, at the depth of seven feet below the surface of the ground, while digging for brick-earth, between Bow and Stratford. Its height was about ten inches, and its greatest diameter about eight inches; it weighed 40 ounces, and had a smaller vase, about the size of a human heart, in its interior. When brought to Mr. Edwards, a watchmaker resident in Shoreditch, by whom it was purchased, it was without a cover, and the contents had been thrown away, with the exception of some black ashes, which were not preserved. Its thickness was about from 0.015 to 0.017 of an inch, its surface presented a dull tarnished aspect, and was stained in patches with red oxide of iron. It was extremely rotten and brittle, breaking by the application of the slightest force; the surfaces of fracture were uneven and of a bright white metallic lustre. When examined under the microscope by a power magnifying 100 diameters, it presented a highly crystaline structure, the facets of the crystals being exceedingly bright and approaching the cubic form, but none of them could be observed perfectly developed; they were more analogous to the characters of grain tin in its broken state as met with in commerce. It appeared, also, as though there had been a recrystalization of the metal, as the particles looked as if they had been drawn from the central part to the sides of the thin plate, leaving cavities or interstices of considerable extent and depth; the exterior surface was also coated with a film of about 0.0005 of an inch thick, having a grayish-olive colour, and totally different in its structure from the other parts, being

striated across its breadth. The specific gravity of the metal in this state was found to be 9.937, great care having been taken to remove the air from the internal cavities by mean of the air-pump.

The metal was next heated to redness in a crucible, and the heat sustained for about ten minutes, after which its characters were found to be totally altered; it had lost its extreme brittleness, requiring to be bent several times before a fracture could be effected, and then, by the aid of the microscope, exhibited a close, small grained tough aspect of a dull white colour, and without the previous cavernous appearances; the superficial film seemed also in places to have partially separated from the substance of the thin plate of metal during the bending. The specific gravity was again taken, adopting the previous precautions, and was found to be 9.95, making an increase of 0.013 on the gravity taken before the application of a red heat.

It was next submitted to analysis; 8.5 grains were digested in dilute nitric acid, and the soluble parts (A) decanted, and the residue well washed. This residue was in small thin grayish-white flakes, and by exposure to the light became rapidly of a purple tint, indicating the presence of chloride of silver; fearing that this might have arisen from some accidental impurity in the materials employed, both the nitric acid and distilled water were carefully tested and proved to be perfectly pure; it was therefore digested in a weak solution of ammonia, which dissolved the whole, with the exception of a small quantity of brown powder, which was found to consist of 0.06 gr. of peroxide of iron and a trace of gold. The ammoniacal solution was precipitated by nitric acid, and gave 0.52 gr. of chloride of silver.—The solution (A) was next precipitated by solution of chloride of sodium, and gave 10.25 grains of chloride of silver, equivalent to 7.66 grains of silver; solution of caustic potash and boiling threw down the oxide of copper, and yielded 0.30 gr. oxide of copper = 0.24 gr. of copper. Thus we have—

Silver	7.66 grains.
Chloride of Silver . .	0.52 ....
Copper	0.24 ....
Oxide of iron . . .	0.06 ....
Gold	a trace
	8.48
Loss .	0.02
	8.50

It becomes a curious question as to the origin of this chloride of silver, which was evidently the superficial grayish film observed under the microscope, and which partially separated in the act of bending the metal after heating. That it must have been produced by the continued action of chlorides, perhaps aided by sulphates present in the brick clay from which the vase was excavated, there can be little doubt, and the peroxide of iron also existing in the clay may have assisted this action.

The passage of the metal to the brittle state in this and in all other cases will, I think, be found attributable to some electrical action aris-

ing from sudden cooling, vibration or concussion, chemical action, &c., to which the metallic body or alloy may have been exposed.

Proc. Chem. Soc.

FRANKLIN INSTITUTE.

Report on the Explosion of the Gun on board the Steam Frigate "Princeton."

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts, to whom was referred for investigation the cause of the Explosion of the Gun on board the steam frigate Princeton, REPORT:—

That they commenced their labors on the 5th of April last, at a preliminary meeting, on board the Princeton, for the purpose of inspecting the gun in place, and for arranging the order, &c., of the investigation. The deliberations of the committee, at this meeting, led them to the conclusion, that a complete and satisfactory examination of the causes of the explosion, would render it necessary to institute a judicial procedure, in reference to the method of proving and firing the gun, requiring a power not possessed by a committee of the Franklin Institute. This difficulty being presented to the applicant, the committee were, subsequently, requested to "investigate the material and workmanship of the gun;" and they have, consequently, limited their inquiry to this part of their original instructions.

In the first place, the actuary of the Institute was directed to address a series of questions, furnished by the committee, to Messrs, Ward & Co., the manufacturers of the gun; and one of the committee was requested to make such drawings and measurements as would facilitate the investigation. To another member of the committee was entrusted the duty of causing to be cut from the gun a number of pieces of iron, in the form of bars, by means of a planing machine, or other instrument, so as not to change the texture of the metal, and which might serve as specimens for testing the quality of the material. The largest of these bars was afterwards given in charge to a member of the committee visiting Boston, to be tested by an apparatus for breaking iron in that city, and the other bars were placed in the hands of the other members of the committee, to be experimented on in Philadelphia, by the breaking apparatus belonging to the Franklin Institute. These duties, assigned to the several members, have been faithfully executed, so far as time and opportunity would permit.

I.—*Inspection of the Gun.*

The committee found the gun broken across, within the trunnion bands; the front part remaining entire, and still, at the time of inspection, in its original connexion with the carriage—the breech part had evidently split into three large, unequal, and irregular pieces. Two of these, according to testimony, passed overboard, and have not since been found; the other piece fell on the deck, at the distance of about thirty feet from the carriage. The appearance of the cross fracture

at the trunnion bands, is shown in Fig. III, and in this, the relative size of the faces of the fractures left by the three segments blown off, are exhibited. The only remaining fragment of the breech part of the gun, that which fell on the deck, is shown in Fig. I. It is five feet long, and, at the larger end, embraces a little more than half of the entire circumference of the gun; (see Fig. II;) at the middle of the fragment, the transverse section forms a sector of a circle of about 120 degrees; and at the end next the trunnions, where it separated from the fore part of the gun, it forms a sector of about 90 degrees, as is shown at *a*, Fig. III. It is evident to the committee as before stated, that the breech part split into three large fragments; but it would appear, from the testimony of persons on board at the time of the explosion, that, besides these, a number of small pieces were thrown off in different directions, some of which are said to have passed through the sails: of the number and size of these pieces, the committee have no means of judging.

II.—*Mode of Construction, and History of the Material of the Gun.*

In reference to the mode of constructing the gun, and the history of the material of which it was formed, Messrs. Ward & Co., readily furnished direct answers to all the questions proposed to them, and expressed a laudable desire to give the committee any information in their possession, which might tend to throw light on the investigation.

The following are the questions proposed to Messrs. Ward & Co.:

1. Of what description, and from what locality, was the ore from which the iron was made?

2. By whom, and where, was the iron made? Was the cold, or hot, blast used? Was, or was not, the iron puddled? Was it manufactured by hammering, by rolling, or by both processes?

3. In what state, and of what size, were the pieces of iron of which the gun was composed? Was the iron introduced into the work in the state of blooms, or bars? If in bars, of what dimensions were they? And were the fags trimmed?

4. Was any substance used to assist in welding? What was the aggregate time during which the gun was kept heated? And what was the average interval during which the surface was exposed in a heated state between the weldings?

5. Please to describe the mode of manufacture of the gun, and the position of the bars severally, as they were welded together.

6. What was the diameter of the shaft made by the first faggot; and the whole diameter of the shaft made by longitudinal bars?

7. Please forward, if possible, specimens of the iron of the gun.

And, in conclusion, the committee will feel much indebted to you for any information which may appear to you to be of interest, in reference to the investigation, and especially in reference to the change of structure, which is supposed to take place in iron under long heating.

To these questions the following answers were given, in the order in which they were proposed:—

1. The ore, from which the bars used in the gun, were chiefly made, was from beds in the vicinity of Clintonville, in this State, (New

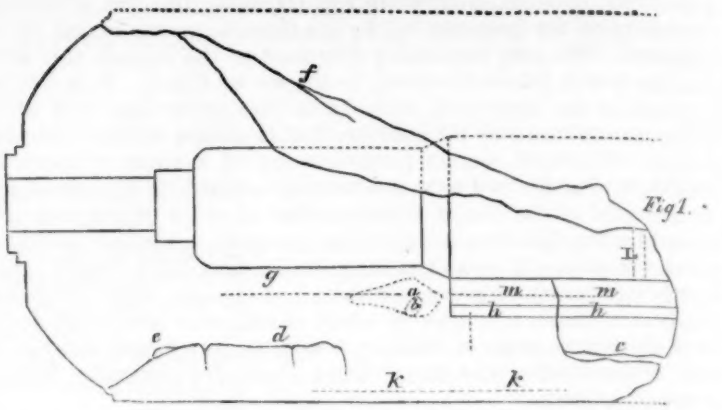


Fig1.

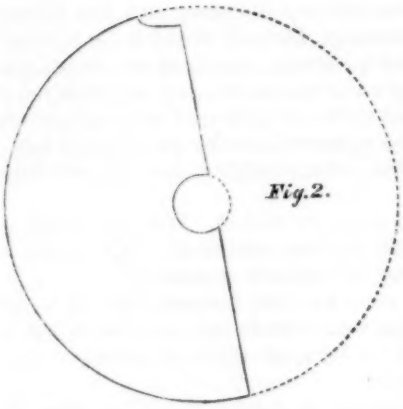
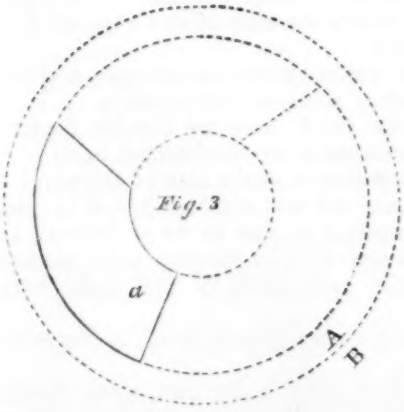


Fig.2.

Fig. I, view of the fractured surface, and of the interior of the bore of the large fragment.

Fig. II, section of the fragment across the large end next the breech.

Fig. III, section across the small end of the fragment shown in Fig. I, near the trunnions.



A, outline of gun under the trunnion bands.

B, outline of the gun at the breech.

Scale, three-fourths of an inch to the foot.

York,) and known as the Arnold and Palmer ore, and we suppose it was used in about equal proportions.

2. The principal part of the iron was made at forges on the Ausable river, in Clinton county, by two, or three, different individuals, and we believe that the hot blast is used by them all; a few hundred weight of the iron used on the small end of the gun, in lengthening it out, was puddled by ourselves, on the old plan, with bituminous coal, and without artificial blast, and the whole throughout was manufactured by hammering alone.

3. Much the largest part of the iron used, was in the form of bars, four inches square, and in length of about eight and a half feet. No blooms were used. A part of the bars, we should think about one-half, were trimmed at the end, the others not; though the bars in the faggot, with which we commenced, reached to the extreme end of the breech, and was then drawn down from twenty inches diameter, to about half that size, and then cut off, by which means the fag ends were effectually got rid off, and, at the same time, the fibre of the iron drawn round the end of the breech to give it strength.

4. No substance whatever was used to assist in welding. Forty-five and a quarter "turns," or days' work, were expended on the gun from the time of commencement to its completion, during which time it was, of course, kept more, or less, heated, and the average time in getting a welding heat, when at the full size, was, on the breech, about four hours, and, on the small end, two and a half to three hours.

5 and 6. The work was commenced with thirty bars, of dimensions the same as before described, laid up in the usual manner of a faggot. These were heated and welded together, and, when so done, rounded up, forming a shaft from twenty to twenty-one inches in diameter. Iron was then laid on to enlarge the size, being, for the most part, prepared in the form of segments, partly from scraps of our own working, and partly from bars, and made of different thicknesses, to suit the position for which they were intended on the gun. The weight of them must have varied from about two hundred to eight hundred pounds; the heaviest ones being put on the breech on which were laid two tiers, or strata, the one being first welded, and then the other upon the top of it. They were of such length usually that three of the segments reached round the body of the gun.

7. We have but two small pieces of the gun, which we had chiseled off from one of the fragments, and which we wish to preserve. We would send them, however, were it not easy for you to get supplied in the same way.

In conclusion, we beg to remark, the iron was such as we had on hand when the thing was ordered, and was not made with any special reference to a gun. It was what we agreed to use in it, and was recommended by us as iron of a good and suitable quality; and of this fact we have evidence the most ample. We had no time for preparation of any sort; the order for the gun being given on, or about, the 4th of July, and the work commenced in two, or three, days afterwards. The iron appears, to some extent, crystalized, though we have seen instances when good iron broken by a sudden

and violent force, appear much more so. With regard to its density, no doubt, this will vary slightly in different parts of the gun, some parts having been expanded, by long heating, after it had become of such a size, that no hammers, at present known, could affect it much, though the hammer, under which this piece was made, weighs fifteen thousand pounds. The weight of the gun, before being bored, was twenty-seven thousand three hundred and ninety pounds. Iron when long heated, and not much drawn, we apprehend, in all cases, loses something of its fibrous properties, and assumes a more crystaline appearance.

Your committee, we trust, are aware that the gun stood a charge of $49\frac{6}{10}$ lbs. of powder, with a ball, in the coldest weather of the past winter, and this under the disadvantage of being secured firmly down, and not in a carriage were it could recoil. It occurs to us to mention, that the bands which we made for the other gun, and which held it together for more than a year past, were made from the same kind of iron as that of the exploded gun."

Although the information contained in the answers of Messrs. Ward & Co., rests on voluntary testimony, yet the committee place the fullest confidence in its accuracy, so far as it is derived from the personal observations of these gentlemen. The answers, however, do not state distinctly the process of manufacturing the iron, of which the principal part of the gun was made; and, on this point, the committee have since received information, also entitled to credit, that at the forges mentioned by Messrs. Ward & Co., the iron is formed directly from the ore, and without piling. Although iron thus prepared is called, by some, a good "merchantable article, the committee consider it of an inferior quality for purposes where great strength is required.

III.—*Examinations relative to the homogeneity of the Metal, the Welding, &c.*

In order to a preliminary examination of the quality of the material, pieces from different parts of the large fragment, were broken off, and the fresh fracture, exhibited by these carefully inspected. The surfaces of these pieces were found to vary from a fine granular, to a coarse crystaline texture, and in one specimen, the face of a crystal was exhibited three-fourths of an inch long, and half an inch wide. The faces of the crystals were not in the general plane of the fracture, but in various planes; and the comparison of all the pieces fully showed great want of homogeneity in different parts of the gun.

It may, however, be proper to remark in this place, that the committee were convinced, from their own experiments, during the course of this investigation, that the difference of the appearance of the fracture of different pieces of iron, depends very much on the manner in which the breaking has been produced. In two fractures made in the same bar, the one by indenting with a chisel, and then breaking across an anvil, and the other by a gradually increasing pull, the latter exhibited a fibrous structure, without the appearance of a single crystal, while the other was pronounced, by a workman, to be the fracture of a piece of inferior crystaline iron. It also appears from

the experiments of the committee, that although the fibrous fracture indicates a considerable degree of ductility, it can, by no means, be relied on as an indication of the tenacity of the metal. In one case, two pieces of remarkably soft and pliable iron, which exhibited a perfectly fibrous texture, when pulled apart were found to possess about four-fifths of the tenacity of a piece of iron which exhibited, under the same circumstances, a granular texture.

The committee, however, are convinced, that when the fractures are produced in the same manner, as by means of a sudden transverse force, the appearance of the surfaces does afford, to an experienced eye, an indication of the quality of the iron, and that the same appearance offers a ready method of determining the homogeneity of the structure of a large mass.

The next object of examination to be described, was the surface of the original fracture of the large fragment of the breech. This exhibited, in several places, traces of the original bars of which the gun was constructed; also spots indicating a want of perfect continuity in the metal, which was the more evident, as these were, in some cases, covered with a brittle scale of the oxide of iron, of the thickness of a sheet of drawing paper. The position and relative size of one of these spots is shown at *a*, in Fig. I. It is between nine and ten inches long, and in the broadest part three inches wide. It approaches at its nearest part to within three-fourths of an inch of the chamber, and may have extended into it in another plane oblique to that of the general fracture. Within this spot was observed, what, at first, appeared to be an imbedded lump of stone; it was probably, however, a mere scale of slag, since it was lost sight of in the subsequent operation of cutting the iron. The committee think it probable, that from the direction in which the pieces must have been blown from the gun, and other circumstances, that the rupture commenced near this spot, and that it was the approximate cause of the rupture taking place in the plane exhibited, rather than in any other.

Besides the spots indicating a want of continuity in the metal in the plane of the fracture, the edges of many others in different planes were observed; also a wide solution of continuity was shown throughout a cylindrical surface concentric with the bore, and extending, in one place at least, entirely around the fragment. This was evident from the fact, that oil poured in at the upper side, *f*, came out at *a*, after passing through a distance, within the fragment, of about three feet. Another opening in the prolongation of the same cylindrical surface, is shown at *c*. The sides of this were separated to a distance of a quarter of an inch; and, by inspecting these, it was evident that they had never been welded. Into this opening a wire was thrust to the depth of ten inches. From the end of the same opening, a crack extends into the bore of the gun, as is shown in the drawing. At E, is shown the section of a small cavity of a triangular form, the longer side of which was about an inch, and the shorter half of that length, which has the appearance of having never been filled up. The large solutions of continuity concentric with the bore, were, in all probability, at the place where the large masses described in the answers

of Messrs. Ward & Co., commenced to be welded on to the longitudinal shaft.

IV.—*Experiments relative to the quality of the material of the Gun.*

In reference to the experiments instituted for the purpose of testing the strength of the iron, it is important, in the first place, to refer to the fact, that the pieces for trial were all cut from the large fragment of the breech, and, therefore, from the immediate part of the gun where the burst occurred. The bar sent to Boston, to be experimented on, by a member of the committee, in that city, was cut from the wall of the chamber lengthwise of the fibre; its position is shown at *g*, in Fig. I. For the purpose of comparison, the same member of the committee was furnished by Messrs. Ward & Co., with two bars of iron taken from the same parcel, and supposed to be of the same quality as that used in the construction of the gun.

The following is a report of the experiments and observations made with these bars in Boston, so far as they have an immediate bearing on the questions to which the committee are restricted. It should be recollected, that they were made by one of the members of the committee, and without a knowledge of the results obtained in Philadelphia by the other members:—

"The bar cut from the body of the gun, was reduced in a planing machine, to the size of two inches square, and was subjected to a transverse strain, supported at both ends, on knife edges, twenty inches apart, and the weight applied in the middle. The different weights applied with the deflections, and the permanent set caused thereby, were as follows:—

Weight applied.	Deflections.	Permanent set.
10800 lbs.	.35 inches.	.30 inches.
12825 "	.61 "	.55 "
13950 "	.94 "	.87 "
15570 "	1.22 "	1.15 "
16650 "	1.52 "	1.44 "
17300 "	1.83 "	1.75 "

"The bar endured this strain without exhibiting any cracks, or other indications of approaching rupture. One of the original bars having the same dimensions, was tried in like manner, and gave similar results.

"By these trials, it appears that so far as respects the quality of stiffness, the iron has undergone no change in the process of forging the gun.

"To determine the tensile strength of the iron, or its power to resist being torn asunder by a force applied in the direction of the length of a bar, three specimens were taken from each of the bars mentioned. Two of the specimens taken from each bar, were reduced to a suitable form for breaking by tension, in a turning lathe, in order to have the material in the same state as it existed in the bars, undisturbed by any heating or hammering. The third specimen from each bar was drawn down under a welding heat, at a common smith's forge. All of them were reduced, in the part where the fracture would occur, to an uniform diameter of six-tenths of an inch. The following results were obtained:—

I. From the original bars representing the quality of the iron before welding the gun :

1st specimen from bar A, broke with		45,359 lbs. pr. sq. in.	
2d " " " "		45,359 " "	
Mean,	. .	——— .	45,359
1st specimen from bar B, broke with		50,930	
2d " " "		46,155	
Mean,	.	——— .	48,542

II. From the same bar drawn down under a welding heat.

One specimen from bar A, broke with		39,375	
" " " B, "		49,338	
Mean,	.	——— .	44,356
Mean of six specimens from original bars,		.	46,086

III. From the bar cut from the body of the gun.

1st specimen from this bar unaltered by heating, or hammering, broke with		40,585	
2d specimen from this bar unaltered by heating, or hammering, broke with		36,606	
Mean,	. .	———	38,595
One specimen from the same bar, drawn down under a welding heat,			52,521

In order to compare the iron used in the construction of the Princeton's gun, with other kinds of wrought-iron, the following additional specimens were tested.

Russia iron, the common flat bar, one specimen,			62,644
English rolled iron from different bars,			
Banke's, 1st specimen,		56,896	
" 2d "		56,169	
Mean,	. .	———	56,532
Low Moor, 1st specimen,		58,888	
" 2d "		53,317	
Mean,	. .	———	56,103
American hammered iron from different bars,			
Bridgewater, Mass., 1st specimen,		58,488	
" " 2d "		49,338	
Mean,	. .	———	53,913

Recapitulation of all the kinds of wrought-iron tried, showing the actual and the proportional cohesive power of each at one view.

		lbs. pr. sq. in.	Proportional strength.
Russia iron,		62,644	1.0000
English iron,	Banke's,	56,532	.9024
	Low Moor,	56,103	.8955
American iron,		53,913	.8605
Iron of the Princeton's gun,	Original bars,	46,086	.7356
	As in the gun,	38,595	.6161
	Same reworked,	52,521	.8383

"The results of this examination appear to show that the iron used in forging the Princeton's gun, was originally of an inferior quality,

having only about three-fourths the strength of English iron. It appears also that the original strength of the iron is considerably impaired by the process of welding it into so large a mass as that which formed the gun, the strength before and after welding being about as 6 to 5."

In the opinion of the general committee the specimen of English iron, used in this comparison, is of a good quality, while that of the American is not of the best kind.

The following are the results of experiments made at the Hall of the Franklin Institute, in reference to the quality of the material of the gun:—

I. Experiments with the metal in the state in which it existed in the gun.

	lbs.
1st specimen cut from position marked *h*, near the bore of the gun, being part of the shaft made of the longitudinal bars; strain lengthwise of fibre, broke with a tension on the square inch of	38,400
2d specimen from same place, circumstances same, broke with less than	25,800
Another specimen from position marked *k*, near the outside of the gun, across the fibre,	31,100
2d specimen from same place, circumstances same, less than	31,100
3d specimen, continuation of the preceding, towards the breech,	41,400
Specimen tangent to circle of bore across fibre of shaft made by the longitudinal bars, from position marked L, broke with	23,700

II. Metal from the gun annealed, but not hammered.

1st specimen from position marked *h*, lengthwise of fibre of shaft, made of longitudinal bars broke in two places, the first breaking weight being	36,300
And the second breaking weight,	39,100
2d specimen from same place,	32,800

III. Metal from the gun drawn down at a welding heat, under forging hammer.

1st specimen from the position marked *m*,	58,000
2d specimen from the same,	68,950

Recapitulation.

1. The average tensile force with which the specimens from the interior of the gun broke, when strained in the direction of the fibre, is less than	32,100
2. The specimen from the interior strained in a direction across the fibre, gave	23,700
3. The specimens from the outside of the gun across the fibre, gave an average of less than	34,533
4. Annealed specimens from the interior, strained lengthwise of the fibre, gave an average of	36,067
5. The average of all the specimens from the gun not hammered, is	33,300

6. The average of the specimens worked down under the hammer, is 63,475

The general conclusions from these results are the same as those from the experiments made by the member of the committee in Boston, so far as the two series can be compared.

1. The average strength of the iron as it existed in the gun from both series, is 33,586
2. The average strength of the iron from the gun, after being drawn down with the hammer from both series, is 59,824
3. The average strength of the original bars from the experiments of the first series, is 46,950
4. The average strength of good American iron, from the investigation of a former committee of the Institute, is 60,000

No experiments were made, at the Hall of the Institute, on the original bars of which the gun was formed. Owing to a misapprehension by Messrs. Ward & Co , of the request of the committee, (see question 7, and its answer,) none of the metal in its original state was sent to Philadelphia. The conclusion, therefore, in reference to the quality of the original bars, rests on the experiments made in Boston. In the accuracy of these experiments, the whole committee have the fullest confidence, and in this point the result is also corroborated by the fact of the large size of the bars, and that there is no evidence that the iron had been piled.

Besides the experiments given in this report, the committee commenced a series of others, on the effect produced in a mass of iron by long heating, without cooling—by heating and cooling alternately—by subjecting the metal for several weeks to a constant vibration, &c., but the committee are not clearly of opinion that they can depart so far from the inquiry to which they were limited.

V.—*Conclusion.*

From the results of the whole investigation, the following facts are derived:—

1. *The iron of which the gun was principally made, was capable of being rendered of a good quality by sufficient working.*
2. *In the state in which the iron was put into the gun, it was not in a sufficiently good condition for the purpose to which it was applied.*
3. *As the metal existed in the gun it was, decidedly, bad.*
4. *As to the manufacture of the gun, the welding was imperfect.*

These facts relate exclusively to the gun submitted to the examination of the committee, and are derived from immediate experiment and observation; but, besides giving these to the public, the committee feel bound to express the opinion, that in the present state of the arts, the use of wrought-iron guns of large calibre, made upon the same plan as the gun now under examination, ought to be abandoned, for the following reasons:—

1st. The practical difficulty, if not impossibility, of welding such a large mass of iron, so as to insure a perfect soundness and uniformity throughout.

2d. The uncertainty that will always prevail, in regard to imperfections in the welding. And,

3d. From the fact that iron decreases very much in strength from the long exposure to the intense heat, necessary in making a gun of this size, without a possibility, with the hammers at present in use in this country; of restoring the fibre by hammering. At the same time the committee would not wish to be understood as expressing any opinion whether the construction of a safe wrought-iron gun, upon some other plan, is practicable, or impracticable, in the present state of the arts, inasmuch as this subject has not been referred to them by the Department.

By order of the Committee,

WILLIAM HAMILTON, Actuary.

Philadelphia, August 8, 1844.

Lunar Occultations.

Lunar Occultations visible in Philadelphia, computed by MRS. CHARLOTTE S. DOWNES, from the Elements published with the Occultation list for the United States Almanac.

The Immersions and Emersions are for Philadelphia, mean astronomical time. Im. for Immersion, Em. for Emersion. These abbreviations in *Italics* refer to those Immersions and Emersions which take place on the Moon's dark limb. N. App. for Near Approach.

The angles are for *inverted image*, or as seen in an astronomical telescope, and reckoned from the Moon's North point and from its Vertex around through East, South, West, to North and Vertex again. For direct vision add 180°.

AUGUST, 1844.

Day.	H'r.	Min.	Star's name.	Mag.	From North.	From Vertex.
1	6	59	Im. 16 Piscium,	6	45°	92°
	8	0	*Em.*		263	313
1	13	15	Im. *m* Piscium,	6	350	218
	13	45	*Em.*		305	324
9	14	41	Im. 15 Geminorum,	6	113	164
	15	34	*Em.*		215	299
15	11	51	*Im.* 24 Ophinchi,	6.7	102	53
	12	45	Em.		246	193
23	9	8	*Im.* 33 Sagittarii,	6	120	112
	10	7	Em.		213	193
23	11	31	*Im.* ζ^1 Sagittarii,	6	42	9
	12	6	Em.		282	243
23	11	21	*Im.* ζ^2 Sagittarii,	6	127	95
	11	59	Em.		196	158
26	11	8	*Im.* c^1 Aquarii,	6	43	14
	12	25	Em.		256	239
28	12	20	Im. κ^1 Piscium,	5.6	43	52
	13	40	*Em.*		251	235
28	12	19	Im. κ^2 Piscium,	5.6	81	90
	13	35	*Em.*		213	202
			SEPTEMBER.			
4	15	38	Im. *n* Tauri,	5.6	59°	111°
	16	57	*Em.*		290	327
19	8	43	*Im.* 2150 Bailey,	6.7	70	43
	9	56	Em.		258	220
23	14	28	*Im.* G Aquarii,	6	43	356
	15	25	Em.		266	217